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ABSTRACT

Designed for grades seven through twelve, this guide contains 50 interdisciplinary lessons on energy which were developed to assist Arkansas teachers in incorporating energy education into existing curricula. Program objectives are listed under four broad categories: (1) energy sources, alternatives, and conversion; (2) energy uses; (3) conservation; and (4) limits and impacts. Each lesson follows a uniform format which includes category of objectives, title, related subject areas, energy types, grade level, time, materials, learning objectives, task analysis (prerequisite knowledge and skills), and procedure (preparation, steps in lesson, evaluation, and follow-up activities). A section on teacher background information and student worksheets follow each lesson. A glossary, list of selected references, and program evaluation forms are provided. (DC)

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7 - 12

Arkansas Department of Education

SE 036 243

S.A.V.E

STUDYING ARKANSAS' VALUABLE ENERGY

An Energy Curriculum For Arkansas' Schools

GRADES 7-12

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LITTLE ROCK, ARKANSAS
1981

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PREFACE

In recent years Arkansans and Americans have become increasingly concerned about the energy dilemma and its important role in their lives. New research and technology can alleviate part of the problem but an immediate source of relief can be the reduction of energy use. Effective energy conservation can result in substantial savings in energy consumption and extend the longevity of present energy supplies.

The energy situation provides almost endless possibilities for students to learn about the world, their nation, their state, and themselves. The comprehensive and complex nature of the energy situation provides an excellent base for the study of the interactions and relationships among resources, environment, economics, society, politics, and behavior.

Energy brings challenge and opportunity to education. The challenge is basic: preparation for survival. The opportunity is to learn from real world problems and to demonstrate how education can contribute to solutions.

The younger generation is the key to the solutions of our energy problem. They also stand to enjoy or suffer the consequences of the problem. The subject of energy, containing some of the most crucial issues of our time, deserves a place in the school curriculum at all levels in all subjects. Energy is an essential element of everything we do.

Studying Arkansas' Valuable Energy represents an effort by the Arkansas Department of Education to assist the schools of Arkansas in planning and carrying out effective energy education programs. It is hoped Studying Arkansas' Valuable Energy will increase awareness and understanding of the energy situation and will encourage each student to become an energy conservationist.

Studying Arkansas' Valuable Energy is premised on the following:

SOURCES, ALTERNATIVES, CONVERSIONS

Individuals should understand that:

- there are many sources of energy.

- presently fossil fuels provide most of our energy sources but alternative sources including direct solar, hydro, wind, nuclear fission, biomass, geothermal, and nuclear fusion must be considered and/or developed.

- energy/matter is a fixed commodity being neither created nor destroyed but converted from one form to another; individuals should understand the means of conversion and the by-products of conversions.

USES

Individuals should understand that:

- energy is so basic that nothing moves or is accomplished without it.
- people are dependent upon energy.

in the United States 75 per cent of our energy is derived from oil and natural gas; in Arkansas we have almost 90 per cent dependence on oil and natural gas.

CONSERVATION

Individuals should understand that:

- the supply of energy sources is finite; the need for conserving energy supplies is real and urgent.
- efficient use of energy resources is one of our best ways of maintaining our current life style.
- half the energy being used in the United States (and in Arkansas) is wasted.

LIMITS AND IMPACTS

Individuals should understand that:

- the earth's resources are limited.
- man's use of energy creates an impact on the environmental and economic systems.

Studying Arkansas' Valuable Energy is intended to aid Arkansas teachers in integrating energy education into existing curriculum. The lessons are designed to be used by classroom teachers in grade levels K - 12. Most of the lessons require the students to be actively involved, both with other students and in actual use of materials.

The lessons have been designed with an interdisciplinary approach, and an attempt has been made to provide a flexible "package" which may be adopted or adapted to fit particular classroom needs. The instructor is free to modify lessons (or activities within lessons), and to use as many or as few lessons and activities as desired or needed.

Each lesson is uniformally organized as follows:

Category (Sources, Alternatives, Conversions; Uses; Conservation;
Limits and Impacts)

Title

Related subject areas

Energy type(s)

Grade level

Time needed to complete lesson (in class periods)

Materials needed

Learning objective(s)

Task analysis (knowledge and skills required of students before
undertaking a lesson)

Procedure

Preparation

Steps in lesson

Evaluation

Follow-Up activities

These lessons are continually undergoing field testing and revisions to obtain the best possible materials to present to students. In the event that you, as a classroom teacher, wish to contribute more to the program of energy education, the Arkansas Department of Education will be happy to hear from you. Your comments and suggestions concernng subject matter, organization, materials, and activities will be welcomed.

There are evaluation forms included at the back of the unit. We request that each teacher who uses the lessons complete and return an evaluation form to the address given.

The Arkansas Department of Education wishes to thank the Arkansas Energy Office and in particular, Ms. Carol Gaddy, for reviewing and critiquing the many lessons of Studying Arkansas's Valuable Energy.

Curricular materials used in Assembling Studying Arkansas's Valuable Energy include the following:

Energy and Man's Environment: Energy and Conservation Education: Activities for the Classroom Grades 1-12. Energy and Man's Environment: Portland, Oregon. 1978.

Indiana Department of Public Instruction. An Energy Curriculum for the Elementary Grades. Indiana Department of Public Instruction: Indianapolis. 1979.

Iowa Department of Public Instruction. Energy Conservation Activity Packet Iowa Department of Public Instruction: Des Moines. 1977.

National Science Teachers Association. Interdisciplinary Student/Teacher Materials on Energy, the Environment, and the Economy. United States Department of Energy: Washington, D.C. 1976.

Nebraska Energy Office. Energy Conservation Activity Packet. Nebraska Energy Office: Lincoln. 1977.

North Carolina Department of Public Instruction. Energy Activities -- Making the Most of What We have. North Carolina Department of Public Instruction: Raleigh. 1979.

Oklahoma State Department of Education. Energy Awareness Education. Oklahoma State Department of Education: Oklahoma City. 1977.

Pennsylvania Department of Education. Pensylvania Energy Curriculum for the Middle Grades. Pennsylvania Department of Education. Harrisburg. 1977.

Superintendent of Public Instruction. *Energy Trade Offs in the Marketplace.* Superintendent of Public Instruction: Olympia, Washington. 1980.

Tenneco Incorporated. *Schoolhouse Energy Efficiency Demonstration (SEED).* Tenneco Incorporated: Houston. 1980.

United States Department of Energy. Various Materials. Technical Information Center: Oakridge, TN.

LESSON #1

CATEGORY: Sources

ENERGY TYPE: All

TITLE: What is Energy?

GRADE LEVEL: 7-8

TIME NEEDED: One period

SUBJECT AREA:
Science
Social Studies
Art

MATERIALS:
Empty wooden thread spool
Rubberbands
2 wooden match sticks or pieces of plastic straw
1/4-inch thick wax washer cut from a candle
1 small nail

ENERGY?
WHO AM I?

OBJECTIVES

1. The students will develop a definition of energy based on how energy was used in the past.
2. The students will demonstrate an understanding of what energy is.
3. The students will arrive at an understanding of energy based on motion and work concepts.
4. The students will express the meaning of energy.
5. The students will become familiar with and be able to identify various forms of energy.
6. The students will be able to define and give examples of potential and kinetic energy.
7. The students will investigate potential and kinetic energy considerations. (Optional).

TASK ANALYSIS:

The students should be able to take notes on oral information, then use this information to demonstrate energy concepts; follow directions to construct equipment for experiments (optional).

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 1.6-1.7
   Read Teacher Background Information (1.4 and 1.5).
   Gather above listed materials.

2. Steps in Lesson
   Objective #1: The students will develop a definition of energy based on how energy was used in the past.

   a. Hand out Student Worksheet 1.6. Have students study the sheet and define energy in terms of the ways it has been used in the past. Have them name ideas about energy that each picture suggests.

-Stone age human: movement, fire, heat, light.
-Nuclear powered submarine: movement, nuclear.
-Franklin's kite experiment: electricity, wind.
-Coal powered train: heat, movement, burning.
-Camera used in taking a picture: light, movement.

Objective #2: The students will demonstrate an understanding of what energy is.

a. Have several students demonstrate what energy is. Encourage students to use their imagination in working up a brief demonstration for the class; for example, running in place, blowing up and releasing a balloon or rubbing hands together to produce heat from friction. In introducing this activity, suggest that the students consider this question: If you were to show someone what energy is, how would you do it?

Objective #3: The students will arrive at an understanding of energy based on motion and work concepts.

a. Lead the student to an understanding that each demonstration did not actually show what energy is, but rather the effects of energy. What then is energy? Energy is defined as **simply** "the ability to do work."

Objective #4: The students will express the meaning of energy.

a. Have the students choose any medium such as art, music, poetry, drama or others. In this medium the student should try to express this thought: "Energy, what or where are you?".

Objective #5: The students will become familiar with and be able to identify various forms of energy.

a. Discuss forms of energy in class. Name, define and give examples of each type.
b. Using Student Worksheet 1.6, have the student examine each illustration and determine what form of energy is represented.
   -Mechanical, heat
   -Nuclear
   -Electrical, heat
   -Chemical, heat
   -Radiant

Objective #6: The students will be able to define and give examples of potential and kinetic energy.

a. Discuss potential and kinetic energy with the class, referring to examples given in Teacher Background Information 1.4 and 1.5.
b. Hand out Student Worksheet 1.7. Do this activity as a teacher demonstration or student experiment. Discuss answers to the questions in class.
c. Have the students distinguish between examples of kinetic and potential energy.

-Stretched rubber band__released rubber band__
-Moving car__parked car__
-Falling baseball__baseball in pitcher's hand__
-Firecracker__exploding firecracker__
-Flowing stream__stream behind a dam__
-Battery __lighted flashlight__
Have the students suggest other examples.

Objective #7: The students will investigate potential and kinetic energy considerations. (Optional).

a. Answer and discuss the optional questions given on Student Worksheet 1.7.
b. Have the students build a working model of their improved design.

3. Evaluation
A written test can be prepared using vocabulary and definitions from the background material.
Other written or oral materials can be devised to test student recognition of energy forms.

4. Follow-Up Activities
Experiments demonstrating each of the forms of energy can be carried out. For examples, see any physics or earth science textbook.

TEACHER BACKGROUND INFORMATION

Sources:

Energy Awareness in Education. Oklahoma State Department of Education: Oklahoma. 1977.

Energy. Pennsylvania Department of Education. Harrisburg, Pennsylvania. 1977.

Before students can really understand the energy problems facing the world today, they need to know just what energy is. The word "energy" can have a number of meanings. Most scientists prefer to define energy as "the ability to do work," work being a measure of motion or the capacity for producing motion.

The many varied forms of energy can be classified as follows:

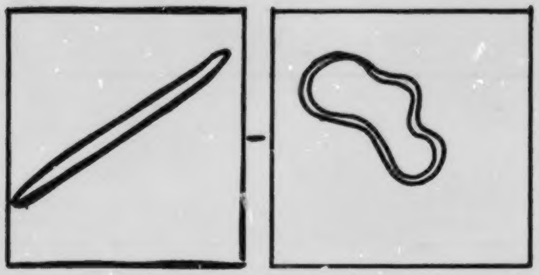
Mechanical:	The energy of motion; energy acquired or released by falling, rolling or sliding objects such as a turning windmill or rotating water wheel. Mechanical energy is apparent with almost every type of human or machine activity.
Electrical:	The energy composed of moving electrons, the movement being caused by the attraction or repulsion of electrically charged bodies (+ and -), and/or by the presence of a magnetic field.
Radiant:	The energy resulting when vibrations of charged particles produce energy in the form of electromagnetic waves or particles which radiate from the source at the speed of light. The sun is the major source of radiant energy for the earth.
Heat:	The energy associated with the random motions of molecules, atoms or smaller structural units, of which matter is composed. Heat energy can readily be transferred through a contact medium.
Chemical:	The energy released or used up during an interaction between the electrons of various atoms (in chemical reactions); rusting of iron, the burning of fuels such as coal and biological reactions such as photosynthesis and respiration. In most chemical reactions, energy is released or absorbed in the form of heat.
Nuclear:	The energy released or used up during alterations within the nuclei of atoms.

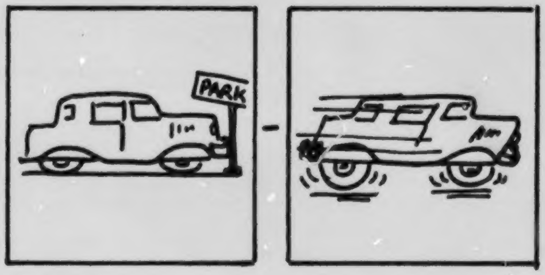
Two general categories of energy that encompass all of these various forms are potential energy and kinetic energy.

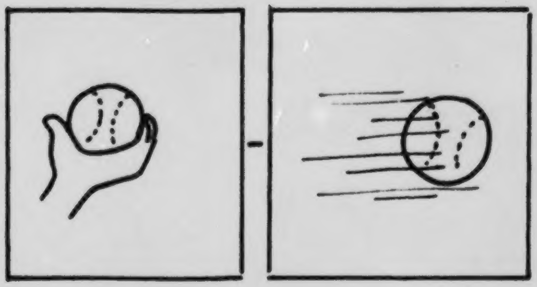
Potential energy is stored energy that an object has because of its position or condition. For example, a tightly stretched rubber band has potential energy; it has the ability to do work if released. A pile of coal has potential energy, since work can be done when the coal is burned.

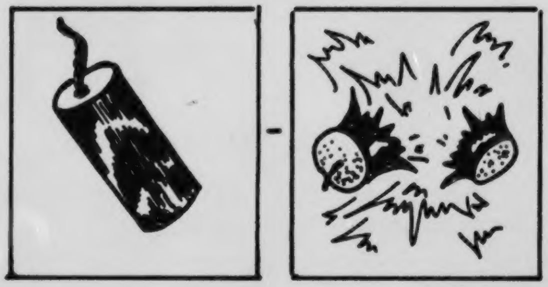
Opposed to stationary potential energy is kinetic energy, the energy that an object has because of its motion. When the stretched rubber band is released, it has kinetic energy. The coal, while burning, also has kinetic energy.

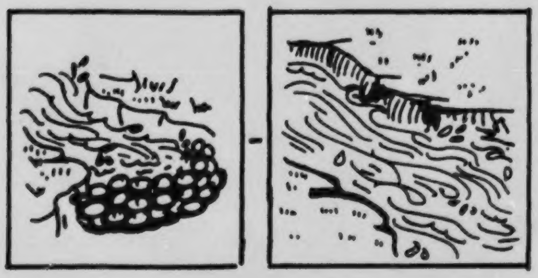
Potential energy represents work that has already been done. For example, suppose someone lifts a rock off the ground. As a result of this work, the rock possesses potential energy. If the rock is allowed to fall, its potential energy is changed into kinetic energy. At the instant it strikes the ground, the kinetic energy is also gone, having been changed into some other form of energy (usually heat).

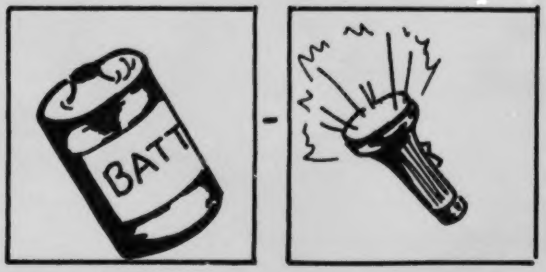






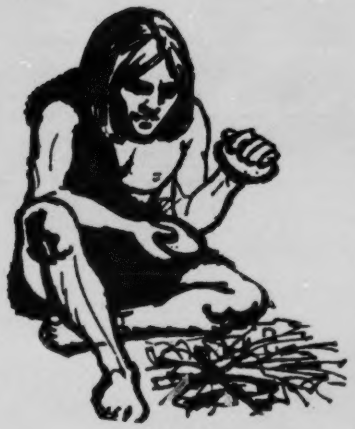


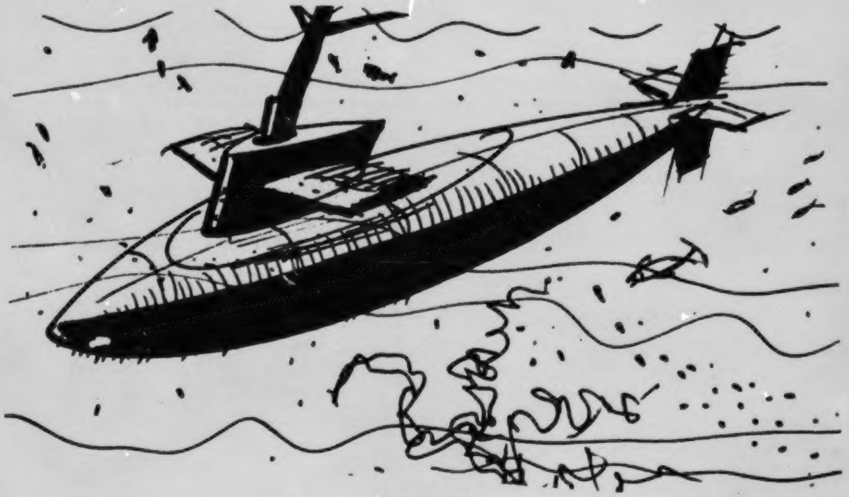


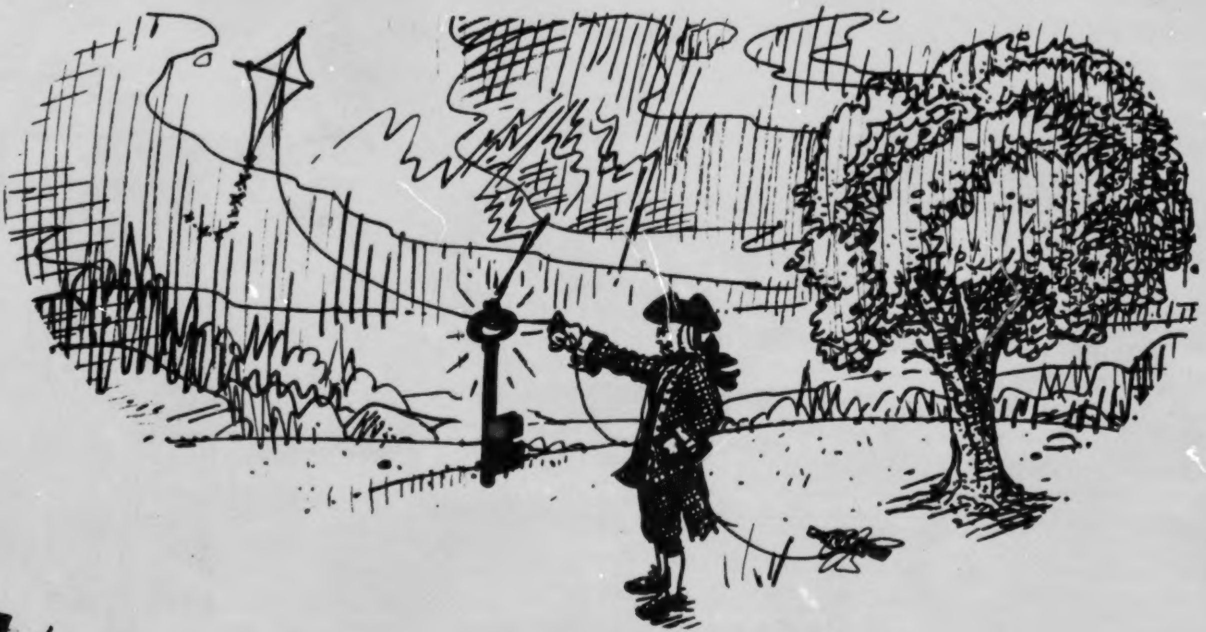


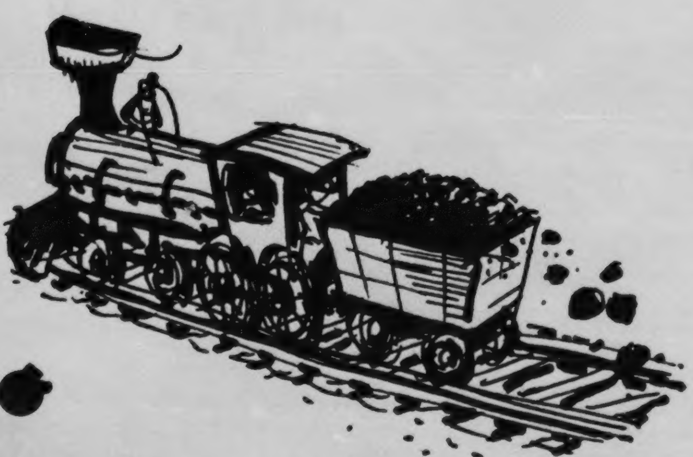
Student Worksheet

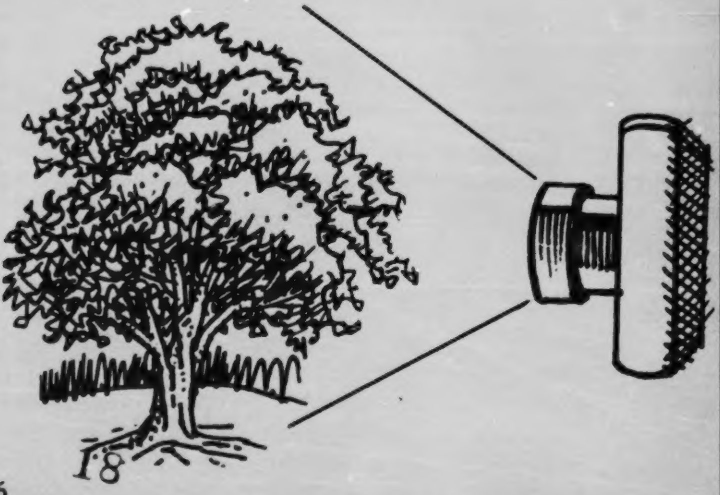
ENERGY USES





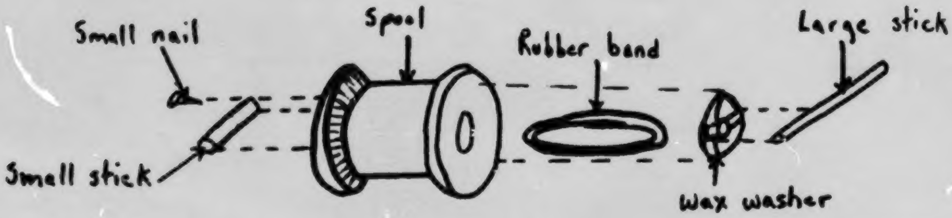






Student Worksheet

MINIATURE POWER PLANT



Follow these directions to construct your power plant.

1. Drive the nail into the spool, about 1/8 inch from the hole.
2. Cut 1/4-inch thick (round) slab of wax. The end of the candle can be used for this. Bore a hole in the center and notch one side.
3. Thread the rubberband through the wax washer and the hole in the spool; loop it over the long stick at the end with the wax washer and over the short stick at the end with the nail.
4. Wind the long stick about 10 to 20 turns, place on a flat surface and release. The spool should move forward at a slow even rate.

Answer and discuss the following questions:

1. Why does the spool move?
2. What is its source of energy?
3. What form of energy does the rubber band have in its stretched condition?
4. Describe its behavior in terms of potential and kinetic energy.

Optional questions.

1. What is the rate of speed of your power plant in:
    a. Inches per minute
    b. Feet per hour
    c. Millimeters per second
    d. Centimeters per minute
    e. Meters per hour
2. What can be done to increase the speed of the spool?
3. How steep (in degrees) an incline plane will the spool climb?
4. How much of a load will the spool pull?
5. Make improvements on the basic design that will increase power and efficiency.

MINIATURE POWER PLANT

ANSWER SHEET

1. The power plant receives energy for movement from the stretched rubber band because work was previously done in stretching the band.

2. The stretched rubber band.

3. Potential.

4. The strected rubber band supplies potential energy to create kinetic energy movement of the spool. Work, as kinetic energy, was previously done in stretching the band to create the necessary potential energy source.

Optional questions.

1. Answers will vary.

2. Wind the rubber band tighter or place the spool on a downhill plane.

3. Answers will vary.

4. Answers will vary.

5. Answers will vary.

LESSON #2

CATEGORY: Conversions

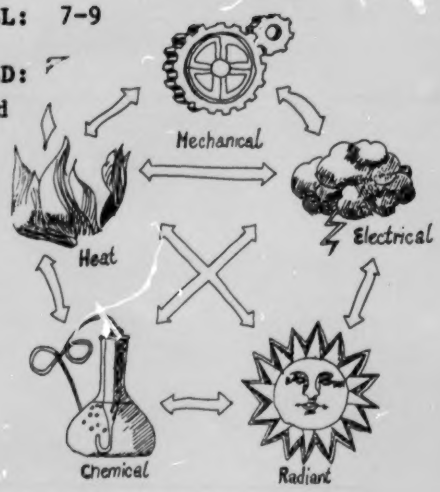
ENERGY TYPE: All

TITLE: Energy Conversions

GRADE LEVEL: 7-9

SUBJECT AREA:
Science

TIME NEEDED:
One period



MATERIALS:

Optional:
250 millileter pyrex flask
Rubber stopper
Glass tube
1 meter of rubber tubing
Eye dropper
Pinwheel
Heat source

OBJECTIVES:

1. The students will be familiar with the first law of thermodynamics.
2. The students will recognize the conversions possible for energy.
3. The students will be able to identify energy by what it does.
4. The students will be able to demonstrate how mechanical energy can be produced from steam in the same way that burning fuels can be used to turn generators for electrical production. (Optional).
5. The students will examine the loss of energy in energy transformations.

TASK ANALYSIS:

The students should be familiar with the various forms of energy and be able to read directional charts.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 2.6 - 2.9.
   Read Teach Background Information (2.4 - 2.5).
   Gather above listed materials (optional).

2. Steps in Lesson
   Objective #1. The students will be familiar with the first law of thermodynamics.

   a. Share in class discussion the material found in Teacher Background Information (2.4 - 2.5).

   Objective #2: The students will recognize the conversions possible for energy.

   a. Hand out Student Worksheet 2.6. Use this Worksheet to follow the conversion of mechanical energy to heat energy. Have the students try to think of other examples of energy conversions.

-Sunlight hits green plants and is converted by them into chemical energy.
-Chemical energy from the plants we eat as food is converted into mechanical energy when we move.
-If we use this movement to pound two rocks together the mechanical energy is converted into heat energy.

Objective #3: The students will be able to identify energy by what it does.

a. Have the students identify energy by what it does by preparing a series of statements similar to these, or by having the student invent his/her own statements.
-When you clap your hands, you change (mechanical) energy to (sound).
-When you are talking, you change (mechanical) energy to (sound).
-When striking a match, you convert (chemical) energy to (heat) and to (light).
-When you rub your hands together, you change (mechanical) energy to (mechanical) energy and to (heat).
-When you flip on a light switch, you change (electrical) energy to (light).

b. Have the students name the energy forms in the following paragraph.

When a fuel such as gasoline is ignited, the ____1____ energy is converted to ____2____ energy. This ____3____ energy is converted to ____4____ energy of the pistons in the engine, which causes the rotation of the flywheel. Some of the ____5____ energy is then used to turn the generator to convert ____6____ energy to ____7____ energy. Some of the ____8____ energy is converted to ____9____ energy for the headlights, and ____10____ energy in the cigarette lighter.

1. Chemical
2. Heat
3. Heat
4. Mechanical
5. Mechanical
6. Mechanical
7. Electical
8. Electical
9. Light
10. Heat

Objective #4: The students will be able to demonstrate how mechanical energy can be produced from steam in the same way that burning fuels can be used to turn generators for electrical production. (Optional).

a. Hand out Student Workseet 2.7. This activity can be done either by teacher demonstration or student experiment. Discuss the answers to the questions in class.

Objective #5: The students will examine the loss of energy in energy transformations.

a. Share the information in Teacher Background Information (2.4 - 2.5) in class discussion.

b. Hand out Student Worksheet 2.8. Discuss with the students the loss of heat energy with each energy transformation. Assign one step to each student for research. Questions for the students to consider might be:
   - How does the actual loss of energy occur?
   - What steps are or could be taken to minimize the heat loss?
   - Is it possible to completely reduce energy loss at this step?
   - What happens to the heat and light energy delivered by the light bulb?
   - Where does all the "lost" energy go?
   - Think of some ways to capture and use this "lost" energy.

3. Evaluation

Using Student Worksheet 2.9, have students fill in the blanks with examples of energy conversions. You may wish to set a time limit and invite more interest by making the task into a game. Challenge students to fill in the blanks within a time limit, counting each correct answer five points. "Winners" would accumulate the highest number of points.

4. Follow-Up Activities

Include more in-depth treatment of processes relating to energy conversions and energy loss:

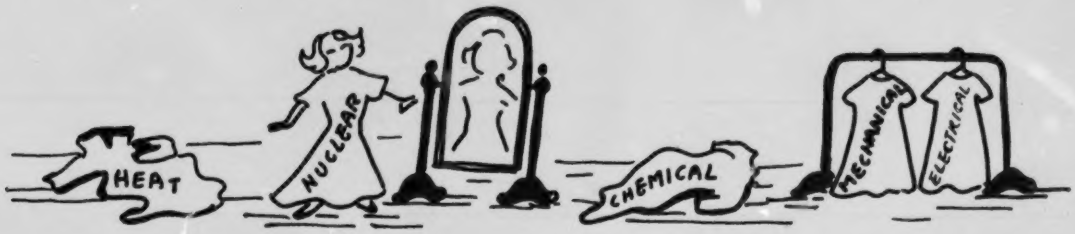
a. The greenhouse effect
b. Energy losses through a food chain
c. Photosynthesis and respiration
d. Energy recovery in the form of recycling and use of solid waste
e. Reduction of energy loss by more efficient use of energy

TEACHER BACKGROUND INFORMATION

Source:

Energy. Pennsylvania Department of Education: Harrisburg, Pennsylvania. 1977.

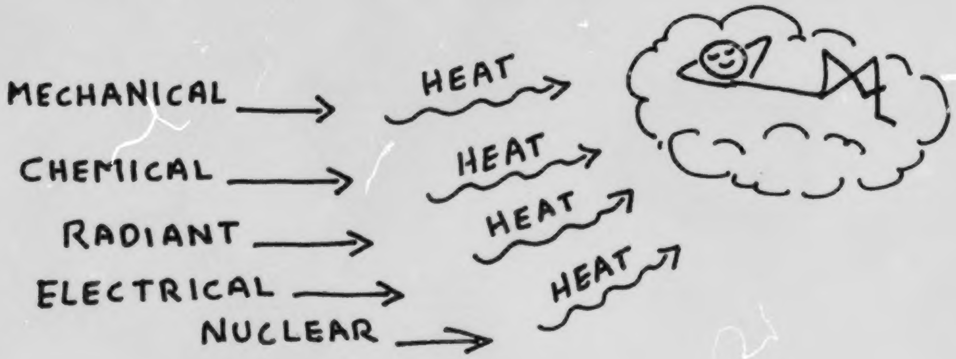
Energy is found in many and varied forms. For example: Mechanical, electrical, chemical, nuclear, radiant and heat. One very important property of energy is that almost any form of energy can be converted into almost any other form. In fact, energy is constantly changing forms.



No one has ever found a way to create energy out of nothing. Furthermore, there is no known way of destroying energy. Energy is never lost. The fact that energy can neither be created nor destroyed is known as the first law of thermodynamics. Under special circumstances, energy can be converted into matter and matter into energy, but this is transformation, not creation or destruction of energy.

One of the largest problems in using energy is the fact that when energy is converted from one form to another, some of the energy is wasted. It is not destroyed; it changes into a form that is no longer of practical use, usually heat, which escapes and is eventually dispersed into space.

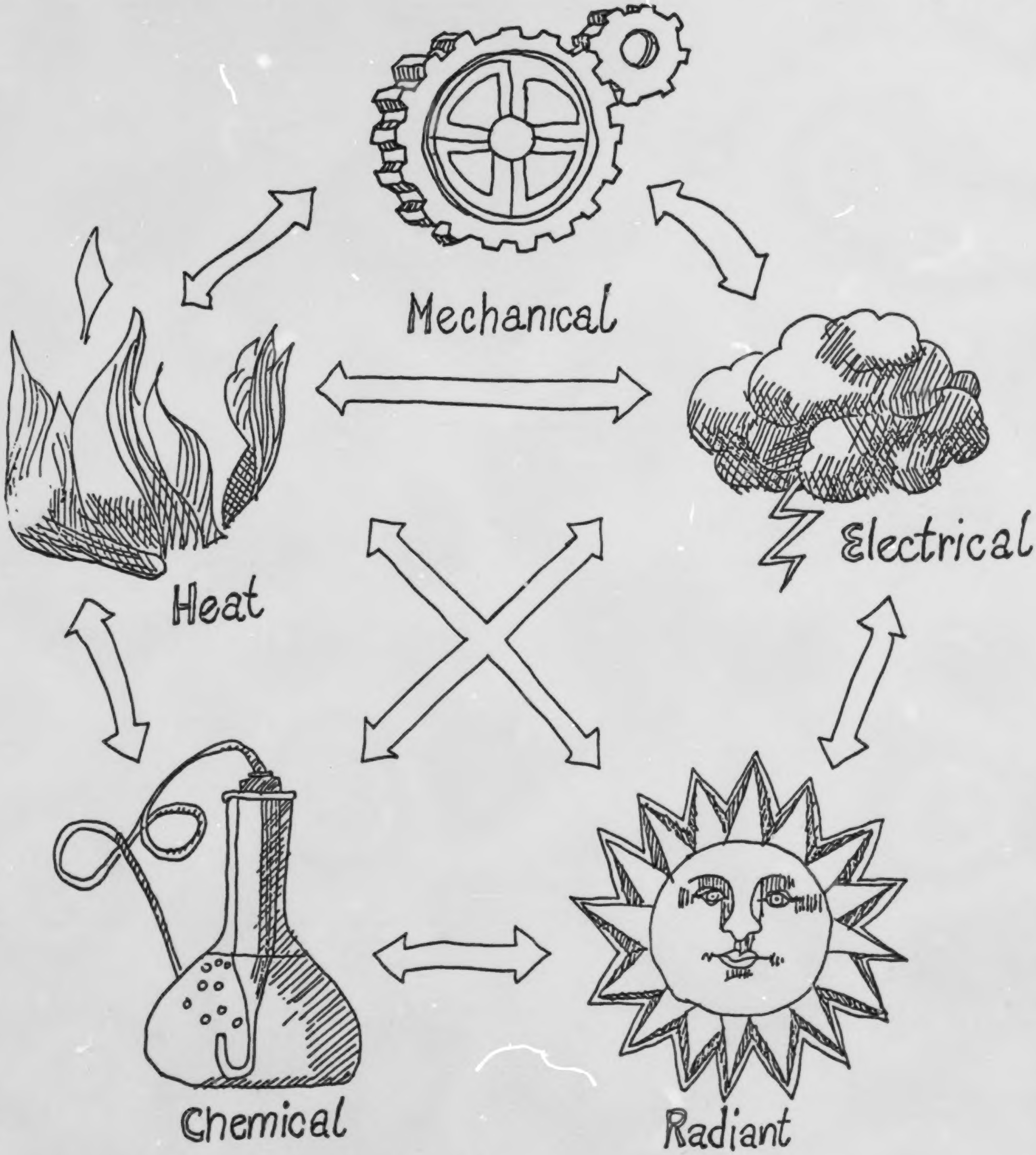
Heat energy can be converted into other types of energy, but a great deal of effort must go into the transformation. On the other hand, other forms of energy can be converted into heat much more easily. There seems to be a definite direction in which energy seeks to flow, and this direction is toward a dilute, scattered form of energy. Scientists call this form "entropy," meaning energy that has become so diluted and scattered it cannot be used ever again to do work.



This inherent wasted heat energy represents a permanent challenge to energy conservationists. It is energy "down the drain" as far as providing useful work to meet energy needs. We must learn to reduce energy waste to acceptable levels, keeping in mind that complete elimination of energy waste is impossible.

Student Worksheet

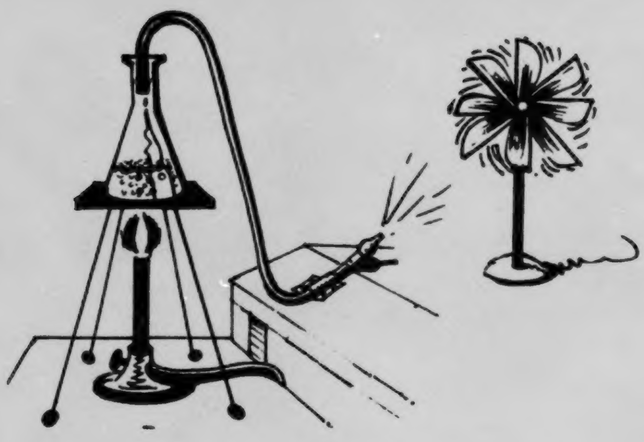
Energy changes from one form to another


Mechanical
Heat
Electrical
Chemical
Radiant

Source: Pennsylvania Department of Education
2.6

Student Worksheet

THE STEAM TURBINE



Follow these steps to construct your steam turbine.

1. Put about 100 millileters of water into a 250 millileter pyrex flask.
2. Fit the flask with a one-hole rubber stopper, put a piece of glass tubing in the stopper, and connect a piece of rubber hose (about 1/2 meter in length) to the glass tube.
3. Attach the glass portion of a medicine dropper to the other end in such a way as to enable the dropper end to be exposed.
4. Heat the water in the flask to boiling. When enough steam has been generated through the tip of the hose mechanism, position the dropper in such a way as to spin the pinwheel.
5. Caution: Do not heat the flask too rapidly. If you produce steam faster than it can escape through the tube, something will give. Be sure to add boiling chips (small glass beads) to the water. Insulate the part of the rubber tube you are holding with a paper towel.

Answer the following questions.

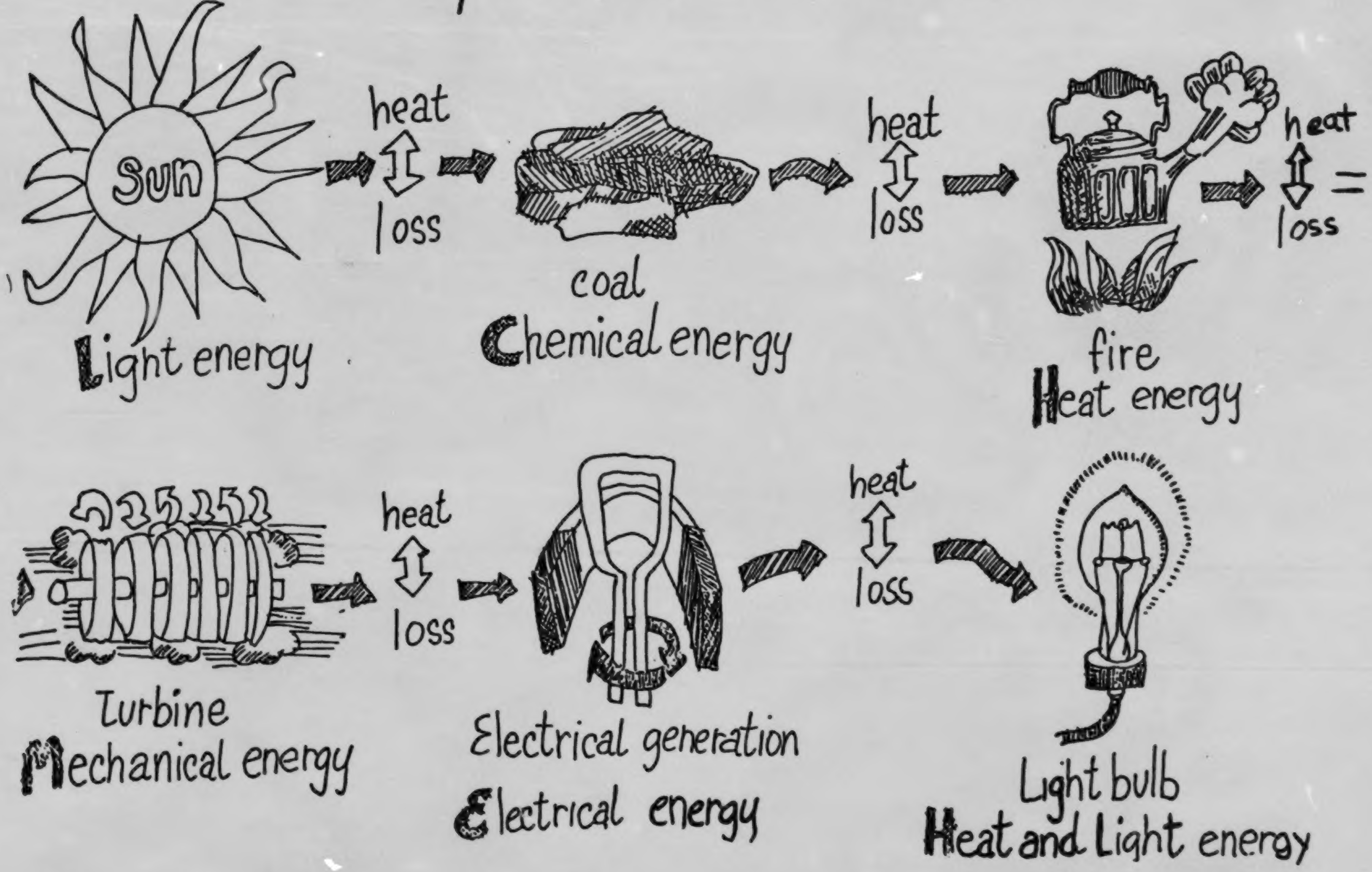
1. What action of your apparatus simulates the action of turbines used to operate an electrical generator?
2. What indicates the production of mechanical energy?
3. Where was the energy stored?
4. How was chemical energy converted? Into what?
5. What did the turbine convert the heat energy into?
6. What use can a turbine be put to?

ANSWER SHEET

THE STEAM TURBINE

1. The spinning of the pinwheel.
2. The spinning of the pinwheel, indicating that work is being done.
3. In the chemical energy of natural gas, alcohol or water.
4. It was converted into heat.
5. Mechanical energy.
6. A turbine is a heat engine. It changes heat energy into mechanical energy and can turn a generator which produces electrical energy.

Energy Transformation


Sun
heat
loss
Light energy
coal
Chemical energy
heat
loss
fire
Heat energy
heat
loss
=
Turbine
Mechanical energy
heat
loss
Electrical generation
Electrical energy
heat
loss
Light bulb
Heat and Light energy

Student Worksheet

ENERGY CONVERSIONS

Directions: Write in each box examples of one form of energy being converted into another form. Begin with the vertical column on the left. Example: Heat is converted into light energy in a light bulb, so write "light bulb" in the box formed by the intersection of the two energy forms.

2.9

	Heat	Light	Sound	Mechanical (movement)	Chemical	Electric	Nuclear
Heat							
Light							
Sound							
Mechanical (movement)							
Chemical							
Electrical							
Nuclear							

SOURCE: National Science Teachers Association

ANSWER SHEET

ENERGY CONVERSIONS

Directions: Write in each box examples of one form of energy being converted into another form. Begin with the vertical column on the left. Example: Heat is converted into light energy in a light bulb, so write "light bulb" in the box formed by the intersection of the two energy forms.

	Heat	Light	Sound	Mechanical (movement)	Chemical	Electric	Nuclear
Heat		light bulb fire electric arc	explosions	steam turbine	disassociation of water or other molecules	thermionic effects	nuclear reactions in stars
Light	infra red absorption			light pressure, photoelectric effect	photosynthesis, other photo chem. reactions	solar cell, other photovoltaic effects	
Sound	sound eventually dissipates as heat	sound converted to modification of laser beam		sound is a mechanical motion of molecules		microphones, telephones	
Mechanical (movement)	rubbing hands -friction in general	non-electric sparks	vocal cords, musical instruments			electric generator	cyclotrons & other high energy machines
Chemical	gas furnaces, fuels in general	fuel burning fire-fly phosphorescence	firecrackers, other explosives			fuel cell battery	
Electrical	incandescent light, iron, cooking	flourescent light, television	telephone speakers, radio, etc.	motor	charging storage battery		
Nuclear	nuclear reactor, fusion reaction	nuclear bomb	nuclear bomb	nuclear bomb		"nuclear batteries"	

LESSON #3

CATEGORY: Sources

ENERGY TYPE: All

TITLE: Our Energy Past

GRADE LEVEL: 7-8

INFUSE WITH SUBJECT AREA:
Social Studies
Reading

TIME NEEDED: Four periods

MATERIALS:

Encyclopediae and other reference materials

OBJECTIVES:

1. The students will perform simple research to complete a timeline covering highlights of energy development.
2. The students will consider the pros and cons of the "good old days" and today's high energy use.
3. The students will consider our dependency on energy sources.
4. The students will discover how petroleum and natural gas have changed American lifestyles during the past fifty years.

TASK ANALYSIS:

The students should be able to use encyclopediae and other reference materials; and be able to conduct an interview type survey.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 3.4 - 3.8.
   (Optional) Invite speaker(s).

2. Steps in Lesson
   Objective #1. The students will perform simple research to complete a timeline covering highlights of energy development.

   a. Hand out Student Worksheets 3.4 - 3.6. Have the students gather facts from encyclopediae and other reference materials to complete the statements on the energy timeline. They will then have an introduction to the modern energy story.

   Objective #2: The students will consider the pros and cons of the "good old days" and today's high energy use.

   a. Have students list reasons why they would have enjoyed living before electricity was in use in homes and before the automobile. Then list reasons why they would not have enjoyed it.
   b. Compare the two lists in class discussion.

Objective #3: The students will consider our dependency on energy sources.

a. Have the students discuss questions such as the following:
   - -What, in your opinion, would happen today if electricity were permanently shut off?
   - -What if gasoline cost $10 a gallon?
   - -Would we survive as well as our ancestors? Why or why not?

Objective #4: The students will discover how petroleum and natural gas have changed American lifestyles during the past fifty years.

a. Hand out and discuss Student Worksheet 3.7. Encourage the students to think up additional questions.
b. Have the students interview older members of the community and fill out the question sheet. When the interviews are complete, discuss the answers in class and tally the results. Ask students if they would like to have lived fifty years ago.
c. (Optional). Invite one of the citizens interviewed (or any older citizen) to speak to the class on past energy uses.
d. (Optional). Invite a person from the Arkansas Energy Office to speak on future energy uses. Ask students how they expect to like living fifty years in the future.

3. Evaluation

Check Student Worksheets for understanding of materials and procedures.

Use oral testing of knowledge and understanding during class discussions.

Have the students write a creative story or essay about energy use in the year ______ (to be chosen by the teacher or student).

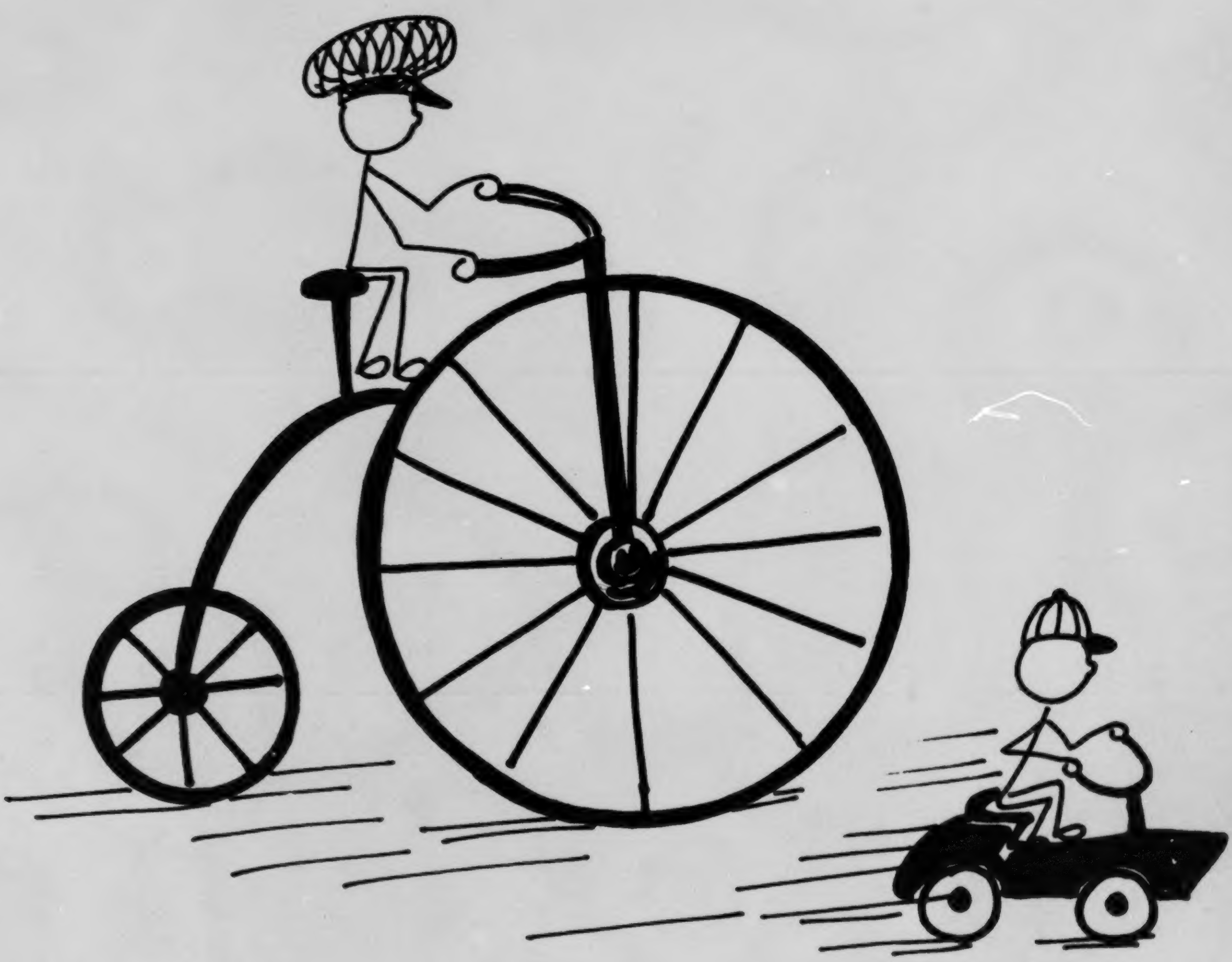
4. Follow-Up-Activities

Take field trips to Arkansas museums nearby to view energy implements used in the past.

Ask students to bring in household implements (or pictures) which use only mechanical or human energy. Include those used today, as well as examples of those used years ago. For example: washboards, egg beaters, can openers, butter churns, apple peelers, etc. Each student should also try to bring in a sample or picture of the modern equivalent of each older article. For example, the modern equivalent of an egg beater would be an electric mixer.

Have students complete the energy past word search on Student Worksheet 3.8.

Have students design a bulletin board showing diagrams of past engines as compared to today's engines. Have the class compare the efficiency of the past and present machines. Ask the students what they expect the future to bring.



THE ENERGY TIMELINE

3.4

Pre-History

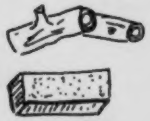
The ____ is essential to life, giving off solar ___ and ____.

500,000 B.C.

Man uses ____ from naturally occuring ____; later learning to make fire using ____.

10,000 B.C.

____ fires are used in the Mid-East in the manufacture of ____.



5000 B.C.

The age of pre-history ends with the first written records.

4500 B.C.

Egyptians store solar ____; and develop the first calendar based on the ____'s year.

4000 B.C.

The age of copper comes about as man learns to work with metals.

3500 B.C.

The age of bronze, a ____ and ____ alloy.

3000 B.C.

Great quantities of ____ are burned to turn $CaCO_3$ into mortar and pottery.

2500 B.C

During the Grecian age people and animals are the main source of ____.

1500 B.C.

The Hittites find a method of smelting ____ that creates better weapons.

212 B.C.

Archimedes uses _____ reflected from Greek shields to repel invading Roman armies.

75 A.D.

A Greek inventor, Hero, makes a toy ____ engine, spun by ____ power.

100 A.D.

Roman Craftsmen _____ bathhouses and homes using ____ windows to trap solar heat.

200 A.D.

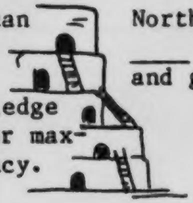
____ is used to power great sailing ships efficiently.

400 A.D.

The main energy sources are still solar, wind, wood and animal.

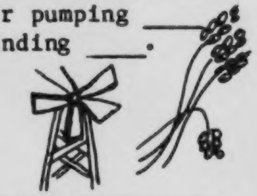
1100 A.D.

Southwestern American Indians, the ____ dwellers, used sophisticated knowledge to build pueblos for maximum _____ efficiency.



1200 A.D.

North Americans use ____ for pumping ____ and grinding ____.

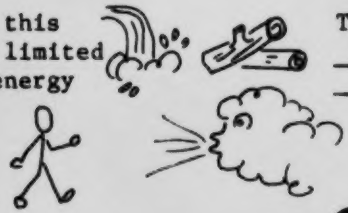


1400

Use of water mills gradually changes from simply grinding grain to that of powering machines for manufacturing.

1600

Advances in this century are limited by lack of energy sources.

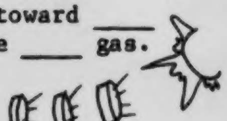


1698

Thomas Savery builds a ____ engine that pumps ____ from coal mines.

1774

Lavoisier uses a series of lenses directed toward ____ to produce ____ gas.



ANSWER SHEET

THE ENERGY TIMELINE

Pre-History	500,000 B.C.	10,000 B.C.	5000 B.C.
The sun is essential to life, giving off solar Heat and light.	Man uses fire from naturally occuring lightning; later learning to make fire using friction.	Wood fires are used in the Mid-East in the manufacture of brick.	The age of pre-history ends with the first written records.

4500 B.C.	4000 B.C.	3500 B.C.	3000 B.C.
Egyptians store solar heat; and develop the first calendar based on the sun's year.	The age of copper comes about as man learns to work with metals.	The age of bronze, a Cu and Sn alloy.	Great quantities of wood are burned to turn $CaCO_3$ into mortar and pottery.

2500 B.C	1500 B.C.	212 B.C.	75 A.D.
During the Grecian age people and animals are the main source of energy.	The Hittites find a method of smelting Fe that creates better weapons.	Archimedes uses sunlight reflected from Greek shields to repel invading Roman armies.	A Greek inventor, Hero, makes a toy heat engine, spun by steam power.

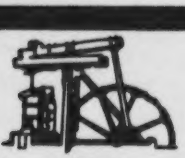
100 A.D.	200 A.D.	400 A.D.	1100 A.D.	1200 A.D.
Roman Craftsmen heat bathhouses and homes using glass windows to trap solar heat.	Wind is used to power great sailing ships efficiently.	The main energy sources are still solar, wind, wood and animal.	Southwestern American Indians, the cliff dwellers, used sophisticated knowledge to build pueblos for maximum solar efficiency.	North Americans use Wind for pumping H_2O and grinding grain.

1400	1600	1698	1774
Use of water mills gradually changes from simply grinding grain to that of powering machines for manufacturing.	Advances in this century are limited by lack of energy sources.	Thomas Savery builds a steam engine that pumps H_2O from coal mines.	Lavoisier uses a series of lenses directed toward sun to produce O_2 gas.

Student Worksheet

cut

1780 1785 1790 1795



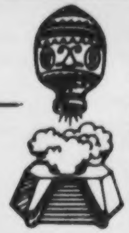
1776

In England James Watt puts two engines to work in factories & starts an energy revolution. The energy is ______.

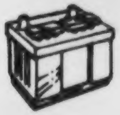
1783

Two men fly in a balloon at ______

The energy used is ______.



Most people burn wood for heating and cooking and travel by horse or on foot.



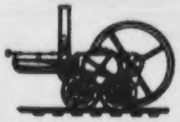
1800

In Italy, ______ invents the battery and gives his name to the volt. The energy produced is ______

cut

1800 1805 1810 1815 1820 1825

3.5

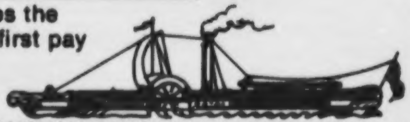


1804

An Englishman Richard ______, puts James Watt's engine on wheels and rails. He is the father of the railroad locomotive.

1807

Robert Fulton doesn't build the very first ______, but he makes the one people first pay to ride on.



Wood continues to supply most household energy needs. But coal begins to do more in factories and railroad engines.

1821

First attempt to develop and market natural gas near Fredonia, N.Y.

cut

1830 1835 1840 1845

1829 An American named ______

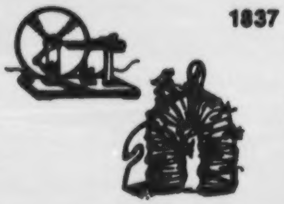
and an Englishman named ______

each invents a generator.

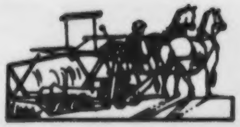
Who is first? ______.

The energy produced?

______



1837 Americans put new inventions to work. First comes McCormick's ______, then the steam shovel by ______, and the telegraph by ______.



Railroads expand rapidly, hauling freight and passengers brave enough to stand the jolts and to risk hot cinders that often fly from the engine into their cars. England is first and America second in railroad locomotive production.

cut

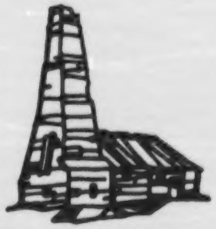
1850 1855 1860 1865 1870 1875

1859

Edwin Drake strikes oil in Pennsylvania beginning the

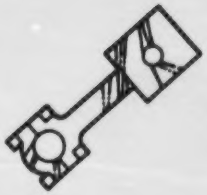
______

industry.



1860

Lenoir of France invents the ______ combustion engine.



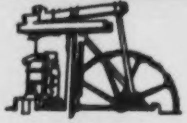
An explosion inside a cylinder paves the way for the later invention of the automobile. An oil strike hastens the discovery of the fuel that will run it.

cut

Student Worksheet

cut

1780 1785 1790 1795

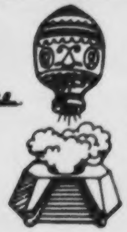


1776

In England James Watt puts two engines to work in factories & starts an energy revolution. The energy is steam

1783

Two men fly in a balloon at Paris, France The energy used is hot air.



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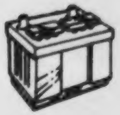
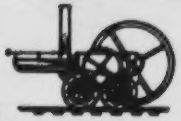


1800

In Italy, Volta invents the battery and gives his name to the volt. The energy produced is electricity

cut

1800 1805 1810 1815 1820 1825



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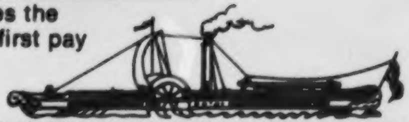


Wood continues to supply most household energy needs. But coal begins to do more in factories and railroad engines.

1821

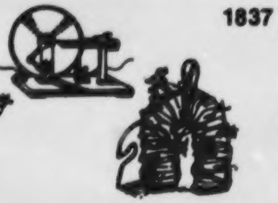
First attempt to develop and market natural gas near Fredonia, N.Y.

3.5a

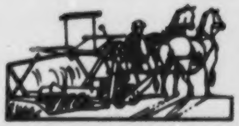
cut

1830 1835 1840 1845

1829 An American named Joseph Henry and an Englishman named Michael Faraday each invents a generator. Who is first? Henry. The energy produced? electricity



1837 Americans put new inventions to work. First comes McCormick's reaper, then the steam shovel by Otis, and the telegraph by Morse.



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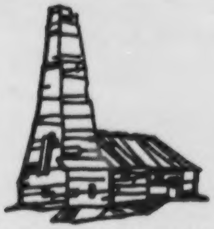
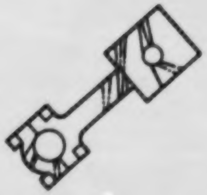
1859

Edwin Drake strikes oil in Pennsylvania beginning the petroleum industry.



1860

Lenoir of France invents the internal combustion engine.



An explosion inside a cylinder paves the way for the later invention of the automobile. An oil strike hastens the discovery of the fuel that will run it.

cut

Student Worksheet

cut

1880 1885 1890 1895

Coal and wood still furnish most of the energy in homes. Coal-fired "iron horses" (railroads) — and real horses — continue to take most people places. Although the electric bulb has been invented most people still use kerosene or gaslights to read by.

1884
In England, Charles Parsons perfects the steam ________ and advances the development of electrical energy.

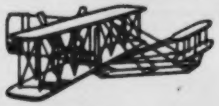
1886
Karl ________ builds the 1st successful automobile.

1892
The oil-burning engine is invented by ________
Eventually, this engine will replace steam-powered ones.

1895
The power of Niagara Fall is harnessed to make ________

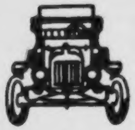
cut

1900 1905 1910 1915 1920 1925



1903
The engine in the Wright brothers' plane is powered by ________

1905 Albert Einstein develops a theory for measuring energy and prepares the way for the ________ age.



1910
Ford makes the first Model ________ car.

By the end of this period, many new homes have coal furnaces in the basement. And more and more cars appear in garages.

cut

1930 1935 1940 1945

1926
Robert Goddard tests a ________.

1936
Hoover Dam on the Colorado River is built to generate ________ power.

1940

________, a fiber made from oil, coal, and water makes its first public appearance.

1942
In Chicago, Enrico Fermi sets off the first ________ chain reaction.

Many homes convert from coal to natural gas for heating. Most families own at least one car and some have two.

cut

1950 1955 1960 1965 1970 1980

1952
Bell scientists raise hope for our energy future with the ________ battery.

1957
The U.S. gets its first big ________ electric power plant at Shippingport, Pa.

Demands for energy grow. America gets more people, more homes, more factories and businesses, more cars, more trucks, more buses, more planes. Demand grows faster than supply.

1970
Congress passes the ________ Air Act.

1973
OPEC nations ________ oil and produce an energy crisis.

1980 Americans continue to look for ways to ________ the energy we have and find new ________ sources.

cut

cut

Student Worksheet

1880 1885 1890 1895

Coal and wood still furnish most of the energy in homes. Coal-fired "iron horses" (railroads) — and real horses — continue to take most people places. Although the electric bulb has been invented most people still use kerosene or gaslights to read by.

1884
In England, Charles Parsons perfects the steam turbine and advances the development of electrical energy.

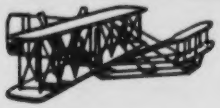
1886
Karl Benz builds the 1st successful automobile.

1892
The oil-burning engine is invented by Rudolf Diesel Eventually, this engine will replace steam-powered ones.

1895
The power of Niagara Fall is harnessed to make electricity

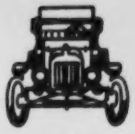
cut

1900 1905 1910 1915 1920 1925



1903
The engine in the Wright brothers' plane is powered by gasoline

1905 Albert Einstein develops a theory for measuring energy and prepares the way for the atomic age.



1910
Ford makes the first Model T car.

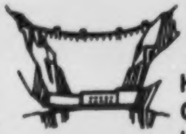
By the end of this period, many new homes have coal furnaces in the basement. And more and more cars appear in garages.

3.6a

cut

1930 1935 1940 1945

1926
Robert Goddard tests a rocket



1936
Hoover Dam on the Colorado River is built to generate hydroelectric power.

1940

Nylon, a fiber made from oil, coal, and water makes its first public appearance.

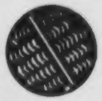
1942
In Chicago, Enrico Fermi sets off the first nuclear chain reaction.

Many homes convert from coal to natural gas for heating. Most families own at least one car and some have two.

cut

1950 1955 1960 1965 1970 1980

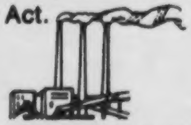
1952
Bell scientists raise hope for our energy future with the solar battery.



1957
The U.S. gets its first big nuclear electric power plant at Shippingport, Pa.

Demands for energy grow. America gets more people, more homes, more factories and businesses, more cars, more trucks, more buses, more planes. Demand grows faster than supply.

1970
Congress passes the Clean Air Act.



1973
OPEC nations embargo oil and produce an energy crisis.

1980 Americans continue to look for ways to conserve the energy we have and find new energy sources.

cut

Student Worksheet

THE GOOD OLD DAYS?

Interview someone who is old enough to remember what life was like before the days of great usage of oil and natural gas. Ask him or her the questions that follow and others that you think of yourself.

1. What kind of lights did you use in your home?
   How was it heated?
2. What fabrics were clothes made of?
   Was clothing harder or easier to take care of?
3. What sort of washing machine did you have?
4. What kind of stove (and what kind of fuel) did your family use for cooking?
5. Did you have a refrigerator?
   How did you keep your food fresh?
6. How was food packaged when it came from the store?
   What did milk come in?
   Was your milk delivered? How?
7. What sort of soap did you use?
   Did it clean as well as the cleaners we have now?
8. How was your water heated for bathing and laundry?
9. Did your family have a car? If not, how did you travel?
   How did you get to school?
10. Did you have a radio? What did it look like?
11. Did you go to the movies? What kinds of entertainment did you enjoy?

(Think of as many more questions of your own as you can. Ask them during the interview. Put the answers on the back of this paper).

To close the interview, ask the following questions; write the answers on the back of this paper.

In what ways is life for you more enjoyable now that we have electricity, plastics, detergents, and other oil and natural gas products?

In what ways did you like the "good old days" better?

Source: Pennsylvania Department of Energy

Student Worksheet

OUR ENERGY PAST

Seek and find sources of energy in Arkansas' past.

m l d e f p u a
u e w a t e r r
e f o i b a m k
l e o a l t y a
o b d r g a s n
r t s k u y c s
t s t e a m l a
e l f i r e p s
p a c o a l t s
e l a m i n a c

Unscramble the energy words found in the puzzle above

wodo
ratwe
dwin
tape
lio
sculem

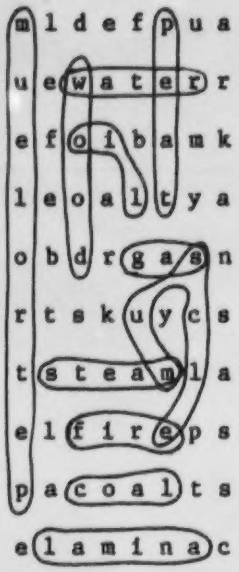
meats
muleprote
sag
cola
rife
inlama

Make up a puzzle of your own, using words from Arkansas' energy past and future.

Student Worksheet

OUR ENERGY PAST

Seek and find sources of energy in Arkansas' past.



m l d e f p u a
u e w a t e r r
e f o i b a m k
l e o a l t y a
o b d r g a s n
r t s k u y c s
t s t e a m l a
e l f i r e p s
p a c o a l t s
e l a m i n a c

Unscramble the energy words found in the puzzle above

wodo	WOOD	meats	STEAM
ratwe	WATER	muleprote	PETROLEUM
dwin	WIND	sag	GAS
tape	PEAT	cola	COAL
lio	OIL	rife	FIRE
sculem	MUSCLE	inlama	ANIMAL

Make up a puzzle of your own, using words from Arkansas' energy past and future.

LESSON #4

CATEGORY: Sources

ENERGY TYPE: All

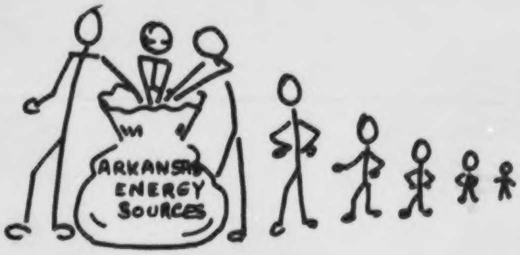
TITLE: Primary and Secondary Energy Sources in Arkansas

GRADE LEVEL: 8-10

SUBJECT AREA:
Science
Social Studies
Math

TIME NEEDED: Three periods

Social Studies
Math



MATERIALS:
Optional: Energy grab bag materials listed on 4.2

OBJECTIVES:

1. The students will recognize the differences between a primary source of energy and a secondary source of energy.
2. The students will recognize the differences between renewable and nonrenewable energy sources.
3. The students will know the primary energy sources that supply Arkansas with most of its energy needs.

TASK ANALYSIS:

The students should have the information and vocabulary necessary to complete worksheets; and be able to read pie graphs.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 4.8 - 4.11
   Read Teacher Background Information (4.4 - 4.7).
   Gather above listed materials (optional).

2. Steps in Lesson
   Objective #1. The students will recognize the differences between a primary source of energy and a secondary source of energy.

   a. Using Teacher Background Information (4.4 - 4.7), present necessary vocabulary and information to students.
   b. Hand out Student Worksheet 4.9. Read and discuss the Worksheet as a group; answer the questions about the diagram in class.

   Objective #2: The students will recognize the differences between renewable and nonrenewable energy sources.

   a. Using Teacher Background Information (4.4 - 4.7), present necessary vocabulary and information to the students.
   b. Hand out Student Worksheet 4.10. Discuss and fill in the worksheet as one group or several smaller groups.

Objective #3: The Students will know the primary energy sources that supply Arkansas with most of its energy needs.

a. Hand out Student Worksheet 4.11. Read and discuss the worksheet as a group; answer the questions about the diagram in class.

b. Do one or both of the following activities:
Divide the class into groups of 3-5 students. Present each group with a grab-bag containing items representing an energy source. The students will take out the items one by one and discuss such things as:

-The specific type of energy source represented.
-Is the energy source primary or secondary?
-Is the energy source renewable or nonrenewable?
-Is the energy source used in Arkansas? If so, to what extent?

Example of items which may be in the bag are:
-Aluminum foil (solar energy and electricity)
-Picture of geyser (geothermal)
-Article of trash (burning garbage)
-Battery (electricity)
-Shale (oil-bearing shale)
-Pinwheel (wind)
-Card with H on it (hydrogen)
-Model of atom (nuclear)
-Leaf (wood, coal, oil)
-Picture of waterfall (hydropower)
-Fern fossil (coal)
-Picture of gas symbol (natural gas)
-Oil can (oil)
-Picture of sun (solar)

Divide the class in groups of 3-5 students. Present each group with a copy of Student Worksheet 4.8. Have the sudents cut the worksheet into squares, then lay the cards face down in the large square. The first player turns up two cards. If the symbol matches the statement, the player picks up the cards and continues drawing until he misses. If the cards do not match, they are turned face down again and play passes to the next student. When all of the cards possible have been matched, the winner is the player with the most matching cards. This Worksheet can also be used in the development of various card games, such as "rummy," "old maid" or "go fish."

3. Evaluation
Oral testing during class discussion of worksheet questions. Use the energy grab bag activity as an evaluation of student understanding. Knowledge of vocabulary can be tested by writing sentences using the words found in this lesson.

4. Follow-Up-Activites

Order and use the poster, "Your Energy World," found in the kit Your Energy World. Available from the United States Department of Energy, Assistant Secretary for Conservation and Solar Applications, Washington, D.C. 20585. No cost.

Interested students can research and give oral reports on uses of various types of energy in Arkansas.

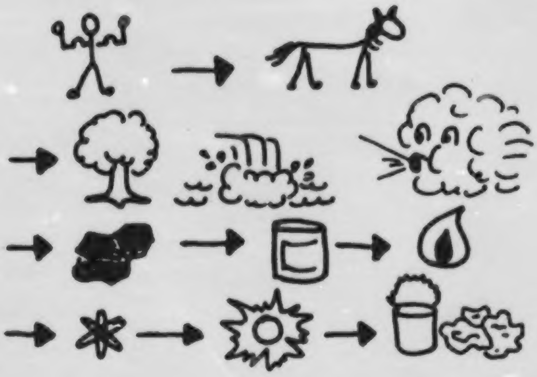
TEACHER BACKGROUND INFORMATION

Sources:

Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

Oklahoma State Department of Education. Energy Awareness Education. Oklahoma City. 1977.

Pennsylvania Department of Education. Energy. Harrisburg, Pennsylvania. 1977.



Energy, in its basic scientific sense, is the capacity to do work. Throughout human history, people have relied on an increasing number of energy resources to work for them. Originally people relied only on their own muscle power, and later on that of animals to do their work. They sought to expand their resources by using the energy in wood, water and wind. In the 18th century, people began to use the energy of coal, the first fossil fuel to be discovered. Later came the use of petroleum and natural gas. In this century, we have begun to tap nuclear energy. We are also looking closely to other energy sources in an attempt to provide sufficient energy while living compatibly with the environment.

Energy sources which are often familiar to us are really secondary sources of energy; that is, energy in some other form has already been expended to produce the secondary source. An example of a secondary energy source is electricity. In order to generate electricity, some primary energy source, such as coal, oil or nuclear power must be used.

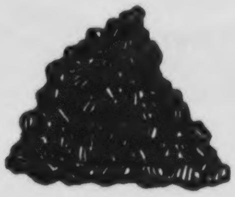
FINITE
RESOURCES

The world's supply of natural resources, especially those which go into the production of energy, is finite. The geological forces which create these natural resources operate so slowly that they can be considered nonrenewable; that is, they can be used up or at least depleted to such an extent that further recovery is too expensive or technologically impossible. These energy-producing resources are being used at ever increasing rates by affluent nations of the world. Until recently little thought or attention had been given to what will happen when these much needed raw materials become scarce or ultimately depleted.

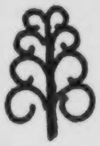
It has been said that "the world has ample natural resources and that we need only new technologies to exploit this wealth." This reliance upon a "technological fix" to solve our problem is very shortsighted. One point that is neglected in this argument is that it requires energy and raw materials to produce end products and usable energy. The traditional sources of energy are becoming scarce because they are created from limited natural resources.

Our renewable resources are resources that cannot be used up, either because they come from an essentially inexhaustible source (such as solar radiation) or they can be regenerated by natural or human-devised cyclical processes (such as running water or growing trees), if they are not used faster than they are renewed.

Some primary energy sources are:

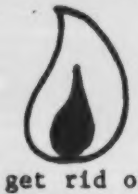


Coal: Solid, combustible organic material containing 55 to 90 per cent carbon mixed with small amounts of hydrogen, oxygen, nitrogen and sulfur. Coal has not been a significant part of the Arkansas energy mix in the recent past, but with the dwindling national supplies of oil and natural gas, coal will probably become an increasingly important component of the state's fuel mix. The primary use of coal in Arkansas energy production will likely be the generation of electricity. Coal is also being considered as a cleaner source of energy by the use of such processes as coal gasification and liquification.

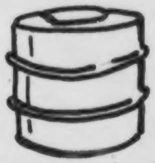


Geothermal: Heat energy produced when subsurface rocks are heated to high temperature by energy from the decay of radioactive elements in the earth. Arkansas has geothermal potential and may participate in the development and utilization of this energy resource. Large heat sources, relatively close to the surface, occur in a large part of the Ouachita Mountains of West Central Arkansas.

Hydropower: Conversion of mechanical energy in falling water to electrical energy by means of a turbine generator. Hydroelectric development in Arkansas has steadily increased over the past decades. All of Arkansas has sufficient rainfall for adequate hydropower. However, only the Northwestern half of the state generally provides variations in elevation sufficient for hydropower development. Promising hydropower in Arkansas might come from the dams on the Arkansas River, the tapping of small dams already existing on Arkansas streams and the use of small, free-standing hydroturbines.



Natural gas: Natural deposits of gases consisting of 50 to 90 percent methane and small amounts of other hydrocarbons such as propane and butane. Natural gas is often found as a by-product in oil wells and in times past was wasted by burning to get rid of it. Only about 30 percent of the natural gas used in Arkansas is produced within the state. There are two natural gas-producing regions in Arkansas: Eight counties in the Southwest section and eleven counties in the Northwest. The remainder of the natural gas used in Arkansas originates in Louisiana, Oklahoma and Texas.

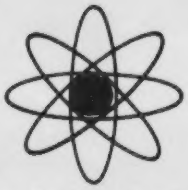


Petroleum: Liquid, combustible, organic material containing a mixture of hydrocarbon compounds plus small amounts of oxygen, sulfur and nitrogen compounds and found in natural subsurface reservoirs; when refined produces many distillates, such as diesel fuel, propane, fuel oil, kerosene and gasoline. Only about one-third of the petroleum products consumed in Arkansas is produced within the state. The balance is satisfied from out-of-state domestic and foreign sources. There has been a steady decline in Arkansas oil production since the early 1960's, largely due to slowed-down exploration efforts because of low-cost foreign oil. Oil production is confined to eight counties in Southern Arkansas; however, two potential petroleum-bearing areas of Arkansas have received some attention lately. Interest concentrates on certain rock formations north of the Arkansas River and in Southeastern Arkansas.

Solar (direct use): Energy produced by the fusion reaction occurring in the sun, which reaches the earth as radiant energy. Arkansas, a "sun belt" state, lags behind most other states in solar development. But with the twin spectres of fossil fuel scarcity and spiraling prices, the sun has become a viable alternative energy source, for Arkansas as well as the nation. Sixty to 100 percent of the space heating needs of Arkansas residents can be met by the use of solar energy. The collecting and backup equipment can be costly initially, but in terms of lifetime cost, direct solar energy is economically attractive in Arkansas. Direct solar energy can be utilized by either passive or active systems. A passive system uses solar energy directly and is the simpler method to use. Adding passive solar equipment should add no more than 10 percent to the original cost of construction and can save from 80 to 90 percent of heating costs. An active system is usually more expensive than a passive system, but is competitive today with electricity costs and will be competitive with natural gas within 1-3 years.

Biomass: Living materials and their waste products, including trees, aquatic plants, agricultural residues, forestry residues, animal manures and urban waste. Presently in Arkansas, wood and wood wastes are the most commonly used forms of biomass. The extensive wood production and wood-using industries of Arkansas offer a large energy potential in wood wastes. Wood bark, chips, shavings, sawdust, waste liquor from paper mills and other mill wastes are all used now as sources of process heat and their use can be expanded. Arkansas, being 55 percent woodland, has more than 18 million acres of potential energy producing trees. Waste conversion facilities for urban solid wastes are appearing in Arkansas. Municipal trash is burned and the heat of combustion recovered for industrial purposes in Siloam Springs, Blytheville, North Little Rock and Osceola. Many other communities around the state are examining the feasibility of installing similar waste heat recovery plants. In addition, a significant amount of methane for fuel can be produced from manure from Arkansas' large poultry industry. After being marketed in many states for several years, gasohol has become available at selected locations in Arkansas.

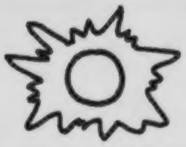
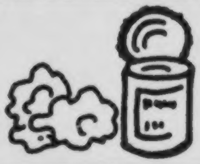
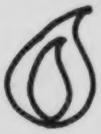
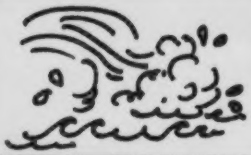
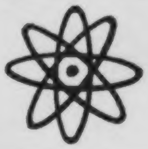
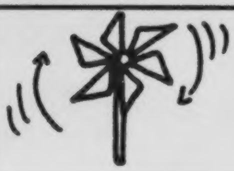
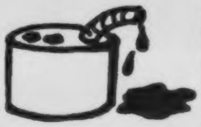
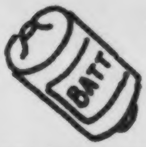
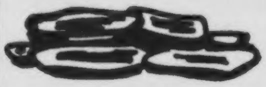
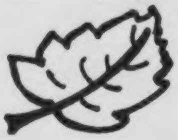
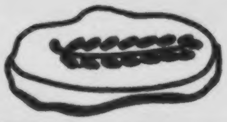
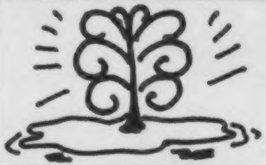
Wind: Mechanical energy of moving air. The overall wind energy potential in the northern half of Arkansas is considered "fair" by wind energy authorities, and the potential in the southern half of the state is labeled "low." Despite its environmental attractiveness as a minimally-polluting energy source, wind power probably will not be able to provide a large part of the total Arkansas energy requirements because of its variability. However, wind power could provide significant power in some sites such as the Ozark Mountains in Northwestern Arkansas and the Grand Prairie in Southeastern Arkansas.



Nuclear: Energy released by a nuclear reaction (fission or fusion). Arkansas Nuclear One, the first nuclear power plant in the Southwestern United States, begain operating in Pope County near Russellville in 1974. A second unit of Arkansas Nuclear One began operating in 1980.

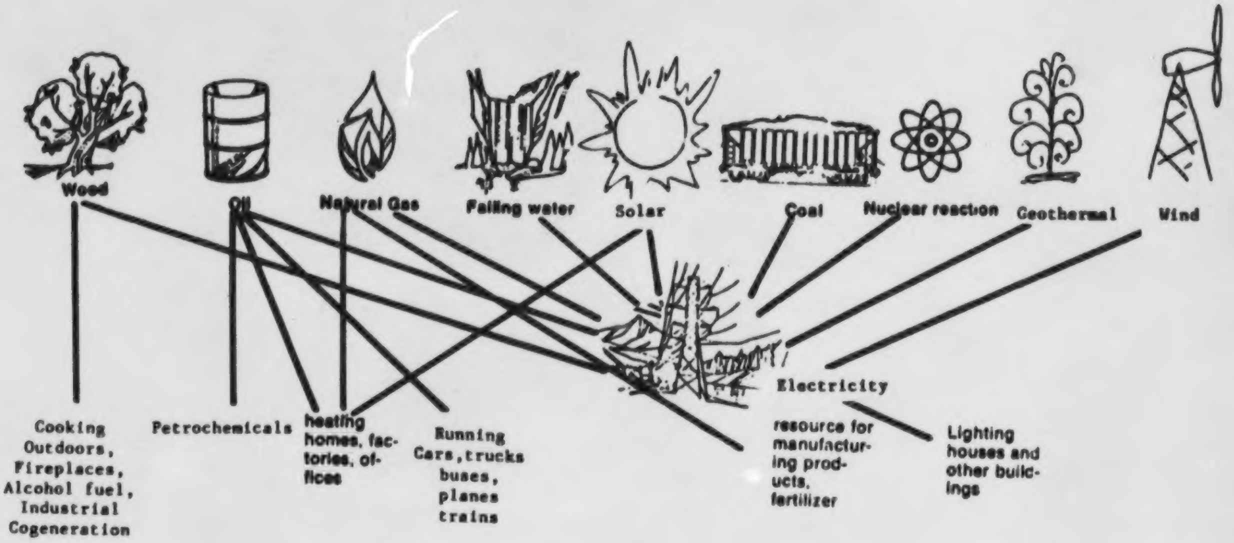
Student Worksheet

CONCENTRATION

	DIRECT SOLAR		BURNING TRASH
	NATURAL GAS		HYDRO-POWER
	NUCLEAR		WIND
H	HYDROGEN		OIL
	ELECTRICITY	INDIRECT SOLAR	FINITE
	OIL SHALE	INEXHAUSTIBLE	SECONDARY
	WOOD	RENEWABLE	PRIMARY
	COAL	NON RENEWABLE	BIOMASS
USED IN ARKANSAS	WILD CARD		GEO-THERMAL

Student Worksheet

PRIMARY ENERGY SOURCES I


Wood
Oil
Natural Gas
Falling water
Solar
Coal
Nuclear reaction
Geothermal
Wind
Electricity
Cooking Outdoors, Fireplaces, Alcohol fuel, Industrial Cogeneration
Petrochemicals
heating homes, factories, offices
Running Cars, trucks buses, planes trains
resource for manufacturing products, fertilizer
Lighting houses and other buildings

The diagram shows nine primary sources of energy. Lines connect each primary energy source to an important work it does.

Answer the following questions about the diagram.

1. Why are these sources known as primary energy sources?
2. Which energy sources are seldom used today?
3. Which do not involve burning to do work?
4. Which ones are used to make electricity?
5. Which four are most important to Arkansas at the present?
6. Which sources are solar related?
7. List at least five secondary sources of energy.

Source: Pennsylvania Department of Energy

Student Worksheet

ANSWER SHEET

PRIMARY ENERGY SOURCES I

1. They produce power directly, using no other source.
2. Wood, waste, geothermal, direct solar, wind.
3. Falling water, nuclear, wind, geothermal, direct solar.
4. All
5. Nuclear, natural gas, oil, coal.
6. Wood, oil, natural gas, falling water, direct solar, coal, wind.
7. Electricity, light, steam, heat, movement, gasoline.

Student Worksheet

PRIMARY ENERGY SOURCES II

Primary Energy Source	Renewable or Nonrenewable	Why?	Secondary Energy Formed	Present Usage In Arkansas
1. Coal				
2. Geothermal				
3. Hydro				
4. Natural Gas				
5. Nuclear				
6. Petroleum				
7. Direct Solar				
8. Biomass				
9. Wind				

Student Worksheet

PRIMARY ENERGY SOURCES II

ANSWER SHEET

1. Coal: Nonrenewable; a finite fossil fuel formed during previous eras by geological processes that operate so slowly that the fuel is depleted before appreciable amounts are reformed.
   Secondary energy formed is electricity and present usage in Arkansas is also electricity.

2. Geothermal: Renewable; a product of the heat generated from the decay of radioactive elements in the earth's crust.
   Secondary energy formed is electricity and present usage in Arkansas is recreation.

3. Hydro: Renewable; an indirect form of solar energy, the water cycle is a never-ending process.
   Secondary energy formed is electricity and present usage in Arkansas is also electricity.

4. Natural gas: Nonrenewable; a finite fossile fuel formed during previous eras by geological processes that operate so slowly that the fuel is depleted before appreciable amounts are reformed.
   Secondary energies formed are heat and electricity and present usages in Arkansas are heating and electricity.

5. Nuclear: Renewable/nonrenewable; finite, but relatively small amounts of the fuel are needed to produce large amounts of energy.
   Secondary energy formed is electricity and present usage in Arkansas is also electricity.

6. Petroleum: Nonrenewable; a finite fossil fuel formed during previous eras by geological processes that operate so slowly that the fuel is depleted before appreciable amounts are reformed.
   Secondary energies formed are movement, heat and electricity; present usage in Arkansas is fuel.

7. Direct solar: Renewable; radiation from the sun, inexhaustible from a human point of view.
   Secondary energy formed is heat and present use in Arkansas is for heating.

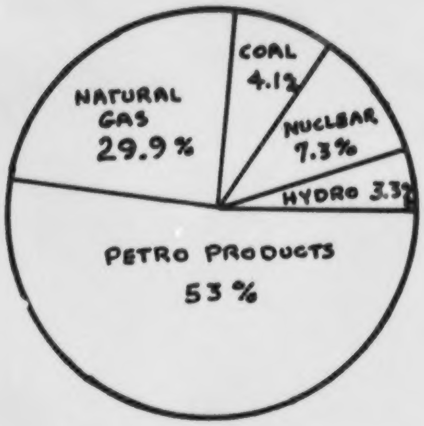
8. Biomass: Renewable; plants grow quickly and waste accumulates quickly.
   Secondary energies formed are heat, movement and electricity; present usage in Arkansas is heating.

9. Wind: Renewable; indirect form of solar energy, virtually inexhaustible.
   Secondary energy formed is electricity and present usage in Arkansas is also electricity.

Student Worksheet

ARKANSAS ENERGY USE

Arkansas Gross Energy Consumption
By Fuel
1978



Total Gross Energy Consumption
761.22 Trillion BTU'S

SOURCE: Arkansas Department of Energy. 1978.

Answer the following questions about the chart.

1. The main primary energy sources used in Arkansas are _______________ (renewable or nonrenewable).

2. Name other primary energy sources used in Arkansas that are not shown on the graph.

3. Give some possible reasons why these sources are not shown.

4. What are some of the ways these primary energy sources are used in Arkansas?

Coal -

Nuclear-

Hydro-

Petroleum-

Natural Gas-

Student Worksheet

ARKANSAS ENERGY USE

ANSWER SHEET

1. Nonrenewable

2. Biomass
   Wind
   Geothermal
   Direct solar

3. Amounts in use negligible as compared to total use.

4. Coal-electricity
   Nuclear-electricity
   Hydro-electricity
   Petroleum-gasoline, petroproducts such as plastics, chemicals, detergents and acrylics
   Natural gas-heating and cooling

LESSON #5

CATEGORY: Sources

TITLE: Meet the Fossil Fuels Sources in Arkansas

SUBJECT AREA:
- Science
- Social Studies
- Reading
- Language Arts

ENERGY TYPE: Fossil Fuels

GRADE LEVEL: 8-12

TIME NEEDED: Two-Five Periods

MATERIALS:
- 10 gallon aquarium
- Ferns
- Sand
- Peat moss
- Water
- Coal
- Slides or chart of geologic time scale

OBJECTIVES:

1. The students will gain an understanding of the nature of fossil fuels, such as coal, oil and natural gas.
2. The students will investigate fossil fuel formation.
3. The students will become familiar with the location of fossil fuels in the United States and Arkansas.
4. The students will research and report on the extraction, transportation and use of fossil fuels in Arkansas.
5. The students will debate the environmental impacts of fossil fuels in Arkansas and/or the United States.

TASK ANALYSIS:

The students should be able to read material and answer questions on that material; and be able to use encyclopediae and other reference materials.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 5.4 - 5.17
   Read Student Background Information (5.4 - 5.8).
   Gather above listed materials

2. Steps in Lesson
   Objective #1. The students will gain an understanding of the nature of fossil fuels, such as coal, oil and natural gas.
   a. Hand out Student Worksheets 5.4 - 5.8. Have the students read the material independently, then discuss as a group.
   b. Hand out Student Worksheet 5.9. Label and discuss each fact as a group.

c. Hand out Student Worksheet 5.10. Have each student work the activity individually, then discuss the answers as a group.
d. Hand out Student Worksheet 5.11. Answer the questions as a group.

Objective #2: The students will investigate fossil fuel formation.

a. Hand out Student Worksheets 5.12 - 5.13. Do the activites as a group.
b. Have the students make charts or models to illustrate the process of fossil fuel formation.
c. Do the following experiment on fossil fuel formation in class:

"Fossil Fuel Formation"

Have the students examine samples of ferns, peat moss and coal. Show the students geologic time charts and describe the physical condition of the earth during the coal forming processes. Then simulate these conditions in the aquarium.

Fill the aquarium with water. Add enough peat moss to make a one-inch layer. Allow one week to elapse. Ask the students to describe the condition of the water. Have them include such things as PH (acidity as tested with litmus paper), odor, turbidity (or cloudiness), decomposition of peat, etc. Ask them if any changes have occurred in the peat. Have students suggest reasons for the changes, or explain why changes did not occur.

Sift moderately fine sand over the peat moss to a depth of one inch. After the sand settles, add an equal depth of peat moss. Repeat the process for as long as desired, or until several successive layers have formed. Ask the students if coal is still being formed today naturally?

Objective #3: The students will become familiar with the location of fossil fuels in the United States and Arkansas.

a. Hand out Student Worksheets 5.14 - 5.15. Have the students answer the questions independently, then discuss the answers in class.

Objective #4: The students will research and report on the extraction, transportation and use of fossil fuels in Arkansas.

a. Divide the class into three groups. Have each group research one of the fossil fuels (coal, oil or natural gas). Have them cover the extraction, transportation, use and environmental problems of each in Arkansas. Encourage charts and illustrations.

Objective #5: The students will debate the environmental impacts of fossil fuels in Arkansas and/or the United States.

a. In class, debate the question: Which fuel has the greatest negative environmental impact: Coal, oil or natural gas? This question may be discussed for Arkansas and/or the United States.

3. Evaluation

Check the answers given by the students on the various Worksheets for comprehension of information.

Oral testing during fossil fuel reports and environmental debate.

Give the fossil fuel test on Student Worksheets 5.16 - 5.17, and check the answers.

4. Follow-Up Activities

Obtain samples of various fossil fuels (types of coal and oil) and examine them with the class.

Prepare or have students prepare, a bulletin board using graphs, pictures, charts and maps about fossil fuel types, uses, pollution and reserves.

Have interested students write letters to major oil and coal companies asking for materials that depict the natural processes by which their energy was formed.

STUDENT BACKGROUND INFORMATION

Sources:

Paul L. Butt. Arkansas and Energy: A Look at the Alternatives
Arkansas Ecology Center: Little Rock. 1979.

Pennsylvania Department of Eeducation. Energy. Harrisburg, Pennsylvania. 1977.

Fossil fuels (coal, oil and natural gas) are remains of dead plants and animals of a previous geologic era that can be burned to release energy.

Coal began to be formed some 350 million years ago as peat beds (partially decomposed organic matter) became covered with layers of rock and soil. The increasing temperature and pressure began to drive off water and organic matter, leaving behind carbon. Coal is graded according to its carbon content: the more carbon, the more energy and less smoke produced by burning.

Anthracite (the top grade of coal) is hard, easy to handle, burns cleanly, has a high energy content and contains very little sulfur (a major coal air pollutant).

Bituminous coal (the most widely used) is relatively easy to handle, burns with moderate smoke production, has an energy content about 25 percent lower than anthracite and, unfortunately, often has a very high sulfur content.

Arkansas is a coal producer, but a minor one when compared with many of the other coal-producing states. Significant reserves of semi-anthracite and bituminous coals are mined in the western Arkansas River Valley. Lower grade coal is imported by rail from Wyoming to Arkansas, not only because it is cheaper than Arkansas coal, but also because it is low-sulfur coal whereas Arkansas coal is classified as high-sulfur.

Environmental impacts from the use of coal are evident in the mining process; getting coal out of the ground without major damage to the environment presents a challenge. In Arkansas, almost all the coal extracted is surface or strip-mined. Surface mining is the process of removing the "overburden" (earth above the coal) by blasting and then removing by giant draglines or huge shovels so that the underlying useful mineral deposits are exposed and can be removed. Surface mining is employed rather than underground mining primarily because it is cheaper due to a lower required capital investment and higher coal recovery. Coal recovery for surface mines is as high as 90 percent while underground mine recovery is 50 to 60 percent.

Generally, surface mining has a more severe impact on the environment. Surface mines can seriously disrupt land, water supplies, wildlife, and humans by causing erosion and making land unfit for vegetation. Water quality can also be degraded by acid draining from mined areas into streams. How much damage occurs usually depends on what measures are taken to reclaim the land - before, during, and after the mining operations. Unless there is reclamation the unrestored land will usually remain scarred and unproductive.

Underground mines have polluted the water, harbored fires, and caused millions of acres of surface land to subside, breaking roads and sewers and collapsing buildings. Underground mining is a hazardous industry in terms of mine accidents and disabling black lung disease.

Public concern and policy in the environmental area has substantially altered the timing and cost of coal production in recent years and will likely continue to be one of the principal controlling factors in coal utilization in the future.

In 1977 both the federal government and Arkansas passed legislation intended to protect the environment from strip-mining. These laws require that the land must be restored to "a condition capable of supporting the uses it was capable of supporting prior to any mining." There is some question as to whether strip-mined land should be restored to its original condition and use, or restored to a different condition and better use. At any rate, an operator cannot strip mine the land unless he can provide definite plans for its reclamation.

Another environmental impact from coal is one that is shared by any fuel used to generate electricity. Electrical generating plants are not very efficient -- that is, a large portion of the energy produced cannot be used to generate electricity, and goes into the environment as waste heat. This heat has negative environmental impacts.

If a power plant is located near an industry which can use the low-grade steam as process heat, or near a community which can use it for residential heating, some of this heat becomes a useful resource instead of a waste to be disposed.

Coal is the most polluting fossil fuel, emitting dangerous toxic metal compounds, cancer-causing radioactive substances, and sulfur oxides and particulates when burned. These air pollutants, especially particulates and sulfur oxides, have been shown to contribute to illness and pre-mature death from respiratory ailments such as asthma, bronchititis, emphysema, and lung cancer.

The sulfur oxides in coal smoke can attack plants directly and also create an acid rain that can leach (flush out) nutrients from the soil, stunt trees and food crops, and kill fish in lakes and ponds. In recent years the acid rains produced by the coal and oil burning emissions of the industrial Northeastern United States have been reaching into Arkansas.

Contemporary Arkansas, like the nation, runs on oil and natural gas. The source of almost 90 percent of the state's primary energy is oil and natural gas. Such dependency on these two fuels has resulted in one of the most difficult problems facing Arkansas today: there is simply not enough oil and natural gas available to meet demands.

Oil and natural gas deposits usually occur together. They are believed to come from animal remains -- mainly marine animals -- as they accumulated over a period of some 50 million years, a shorter time frame than for the formation of coal.

As organisms died in ancient seas, the remains settled to the sea bottom and became buried in layers of mud and sand. This organic matter was changed into the carbon and hydrogen compounds that are oil and natural gas, probably by gradual decay, heat, pressure, and perhaps bacterial and radioactive actions.

Crude oil is refined into many different products. About 90 percent is made into various kinds of fuels: gasoline, jet fuel, heavy duty fuel oil for industries, heating oil and diesel fuel. The rest goes into lubricants and is a vital raw material in thousands of manufactured products such as dyes, medicines, detergents, plastics and artificial fibers (nylon, rayon, dacron).

Petroleum products constitute approximately 56 percent of the total energy used in Arkansas. Of this, about 60 percent is gasoline. The remainder is comprised of middle distillates, residual oils, and liquid petroleum gases (primarily propane). Only about one-third of the petroleum products consumed in Arkansas is produced within the state. The balance of the state's oil requirements is satisfied from out-of-state domestic and foreign sources.

Geologists use various instruments to discover the right conditions for the existence of oil or natural gas under the ground. A derrick is then erected to hold the drills, pipes, and other equipment. Drilling is done, and if oil is found, the crude oil is transported to be refined. If natural gas is found, it is pumped away in pipelines to be used. Wells may be drilled on land or offshore, with a platform provided to support the equipment.

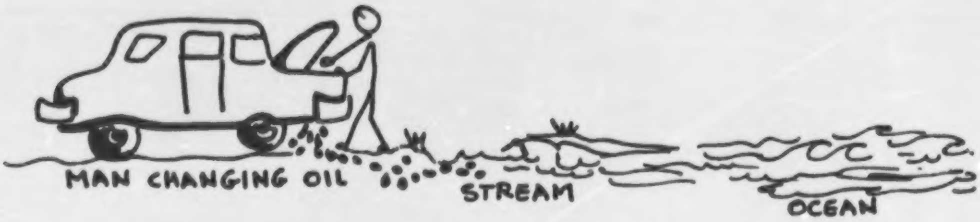
Environmental problems with on-shore wells include: air pollution at drilling sites, contamination of the surrounding area by crude oil when blowouts occur, and brine run-off at drilling sites. Land-based exploration and development of oil (and natural gas) in Arkansas have caused minimal environmental problems.

Off-shore operations present such problems as: the possibility of the direct release of oil fouling beaches and affecting animal life in coastal regions, and fires at oil wells which could cause significant air pollution.

Oil spills and discharges from oil takers which transport crude oil have released millions of gallons of oil when these tankers have run aground or broken up. This oil is washed up on shore or sinks to the bottom, destroying fishing grounds and birds. There are indications that persistent chemicals from oil spills may enter the marine food chain and become a hazard to marine life and perhaps to man.

Oil may also be transported through pipelines, which must be carefully constructed to minimize environmental damage. Pipelines are used to transport natural gas and petroleum in Arkansas from the production fields within the state to both in- and out-of-state refineries and users. Pipelines also bring natural gas to Arkansas users from out-of-state sources and handle interstate transmission of natural gas and petroleum.

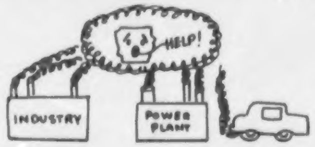
Despite publicity about offshore blow-outs, pipeline breaks, and tanker accidents, more than two-thirds of the oil polluting the world's waters comes from the disposal of waste oils from automobile crankcases and machines, which eventually washes into streams and on to the ocean.



The most damaging of current environmental threats resulting from the consumption of oil is air pollution. All fossil fuels produce air pollution when they are burned; coal is the dirtiest, natural gas the cleanest. But oil is the most significant offender in Arkansas in terms of volume of use. The burning of oil contaminates the air by gases in the form of oxides of sulfur, nitrogen, and carbon as well as hydrocarbons and very fine particulate matter.

The fossil fuels are not merely a part of the air pollution problem; except for the burning of leaves and trash, and the wearing away of rubber tires, they are solely responsible for the entire problem. Unlike water pollution and land use problems where energy consumption is only one factor, air pollution is almost exclusively a result of discharges from motor vehicles (the chief source), fossil-fueled electric power plants, and energy-intensive industries. The air pollution problem seems to result from synergistic effects, whereby the combination of several pollutants causes more damage than would be expected from the sum of each individual pollutant.

Natural gas is largely methane, which is composed of one carbon atom and four hydrogen atoms. Early usage of natural gas tended to be localized because there was no way to transport the gas over long distances; then in 1947, a major change in the industry was brought about when natural gas from the southwest reached the east coast through two converted liquid pipelines. The United States became the leading producer of natural gas in the world and the use of nautral gas increased rapidly.



As a fuel, natural gas has many advantages, such as convenience of transport and clean-burning characteristics. The problem with natural gas is similar to that of oil, only more serious - there simply is not enough available to meet demands. Natural gas is used as a fuel to produce heat, and has become the primary raw material for chemical fertilizer and many other products. At the well, natural gas is compressed and the heavier gas molecules, primarily propane and butane, are separated out as a liquid. These are then transported in pressurized containers and sold as bottled gas. It can be used in the same way as natural gas, and is especially useful in rural areas. Arkansas is a disproportionately large user of propane. Arkansas in recent years has been the largest per-captia-user state, and near the top in total volume consumed of all states.

The supply of natural gas is running out, and though geologists expect additional discoveries, it is not expected to be available as a major source of energy in the United States for more than 20 years.

Student Worksheet

SOME FACTS ABOUT COAL, OIL AND NATURAL GAS

Decide whether each of the following facts is a problem (P) or an opportunity (O). Put a P or an O - or both - in each blank. On the back of the sheet, write down ways some of the problems could be overcome. Compare ideas with your classmates.

_____1. 90 percent of United States fossil fuel reserves (coal, oil and natural gas) are coal.

_____2. Coal is the most polluting fossil fuel.

_____3. Half of the United States' mineable coal is in the Western United States.

_____4. In the future, we will rely more on coal as a source for synthetic oil and gas.

_____5. The formation of fossil fuels is a gradual process that began millions of years ago.

_____6. The source of almost 90 percent of Arkansas' primary energy is oil and natural gas.

_____7. Oil and natural gas deposits usually occur together.

_____8. Oil may be obtained through off-or on-shore wells.

_____9. Oil and natural gas are transported across Arkansas through pipe lines.

_____10. Development of oil and natural gas in Arkansas has been by land-based exploration.

_____11. Fossil fuels are almost solely responsible for air pollution problems, both in Arkansas and the United States.

_____12. In Arkansas, almost all the coal extracted is surface (or strip-mined).

_____13. We have enough coal to last for 350 years, at current level of use.

_____14. Mining and using coal causes damage to the environment.

Student Worksheet

SOME FACTS ABOUT COAL, OIL, AND NATURAL GAS
ANSWER SHEET

1. O
2. P
3. O/P
4. O/P
5. P
6. P
7. O/P
8. O/P
9. O/P
10. O/P
11. P
12. O/P
13. O
14. P

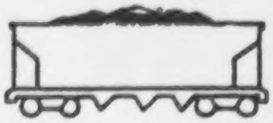
Student Worksheet

FROM MINE TO LIGHTS

Trace the path of coal from the mine to your electric lights by placing the sequential number beside each paragraph. As you do this, answer the questions about each step.

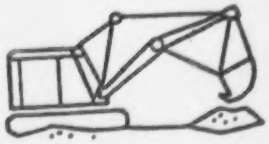
______ Electricity is transported on wires at very high voltages. Electricity is usually not shipped more than 600 miles by wire because of expense and loss of energy. Only 26 percent of the original energy remains when the electricity is used. Can you think of a way to increase efficiency in this step?

______ About two-thirds of the coal in the United States is transported by rail, much of it in special cars. One coal train can carry as much as 15,000 tons per trip. Is Arkansas affected by coal rail lines? What environmental problems will coal transportation cause?

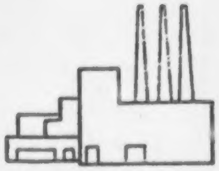


______ Electricity lights the lamps in your home. How many other uses of electricity in your home can you name?

______ Coal is mined either by surface or underground mining. Before it leaves the mine, it is cleaned, crushed, and sorted. What environmental problems could these mining processes cause? How is most coal mined in Arkansas?



______ 46 percent of United States electrical generators are powered by coal. Power plants burn coal to turn water into steam. The steam turns a turbine, a series of wheels with vanes like a windmill. The turbine rotates coils of wire in a generator through a magnetic field to produce electricity. Can you name an Arkansas power plant that is coal-powered? What environmental problems might be caused in Arkansas by this plant?



Could you adjust the path you have just traced for coal to fit oil and/or natural gas? Show how you would do this using the back of this page.

Student Worksheet

ANSWER SHEET

4 Locate power sources nearer to user groups.

2 Coal from Wyoming is imported to Arkansas by rail. Loss of habitat near rail lines, air pollution from engine.

5 Power appliances and tools, heat space and water, etc.

1 Disruption of land, water supplies, wildlife by erosion and loss of vegetation, acid drain-off from the mine, pollution of water table, underground fires, subsiding of land surfaces, etc.

3 Southwestern Electric Power Company's Flint Creek Plant near Gentry (Benton County). Arkansas Power and Light's White Bluff Plant near Redfield (Jefferson County). Air pollution, loss of habitat, thermal pollution.

Oil/natural gas pathway:

1 - Well

2 - Tanker/Pipeline

3 - Refinery

4 - Wholesaler

5 - Retailer

6 - Home

Student Worksheet

MINING OF FOSSIL FUELS

Read each set of statements below. If there were nothing else to consider, would you think that surface or deep mining (or both) is the best way to obtain coal.

	Surface Mining	Deep Mining
_____1.	Each miner can produce 30 tons of coal a day.	Each miner can produce 10 tons of coal a day.
_____2.	90 percent of the coal in a surface mine can be removed.	50-60 percent of the coal in a deep mine can be removed.
_____3.	Forests and fields, along with their topsoil, are turned over before the coal is removed - at a rate of 1000 acres a week. New laws in every state require reclamation, but the cost is added to the price of coal.	Less damage to forests and fields than surface mining.
_____4.	Some coal, very close to the earth's surface, can only be recovered by surface mining.	Some coal, very deeply buried, can only be recovered by deep mining.

It would be easy to decide how to mine coal if there were only one set of facts to consider. As you have seen, however, there are many. What would you say is the main advantage of surface mining? What would you say is the main advantage of deep mining? Can you think of a compromise?

Repeat the above exercise for the drilling of oil/natural gas wells.

	On-Shore Wells	Off-Shore Wells
_____1.	Special heavy weight mud needed to reduce friction of drill-bit in rock.	Large platforms needed to support drilling equipment.
_____2.	Possibility of air pollution through well blow-outs.	Well fires could cause significant air pollution.
_____3.	Danger of brine run-off at drilling sites.	Danger of direct release of oil onto beaches in coastal regions.

Student Worksheet

MINING OF FOSSIL FUELS

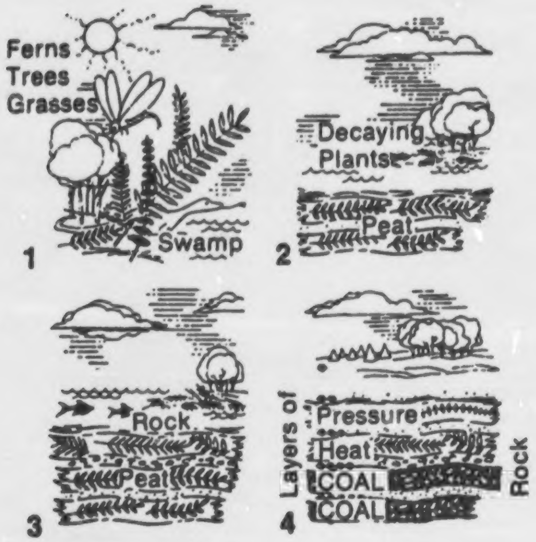
ANSWER SHEET

1. Surface
2. Surface
3. Deep
4. Both

1. On-shore
2. On-shore
3. On-shore

Student Worksheet

HOW COAL WAS FORMED



Place the number of each picture in front of the description that fits it best.

_____ When the giant plants died, they formed rotted vegetable matter called peat. For thousands of years, plants grew, died, and formed layer upon layer of peat.

_____ When the seas were gone again, heat and pressure from the layers of rock changed the peat into coal.

_____ More than 250 million years ago, forests of gigantic ferns, trees, and grasses covered vast swamp lands and stored up energy from the sun.

_____ Later, when the surface of the earth changed, seas covered the land and deposited layers of shale, limestone and other rock on the peat.

Do you think that coal is being formed anywhere on the earth today? What kind of conditions would be necessary for this formation to take place?

If coal is still being formed today, will it help solve the energy problems facing Arkansas and the United States at this time?

Source: United States Department of Energy

Student Worksheet

HOW COAL WAS FORMED

ANSWER SHEET

2

4

1

3

Yes.

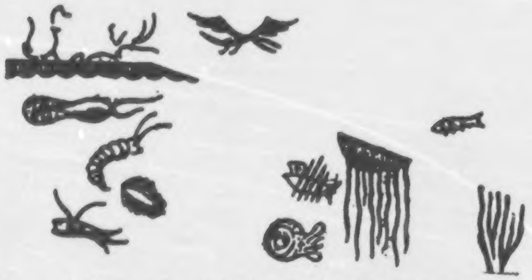
Warm, humid, swampy with layers of rock and organic material lying on top of one another to add pressure.

No, the coal will form too slowly to help Arkansas or the United States out of their present energy crises.

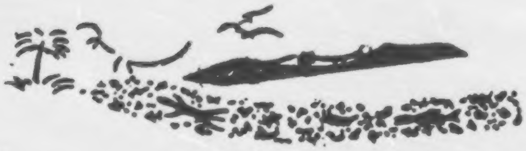
Student Worksheet

THE GENESIS OF OIL AND NATURAL GAS

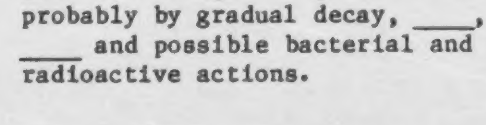
Fill in the missing words to complete the story of the formation of oil and natural gas.



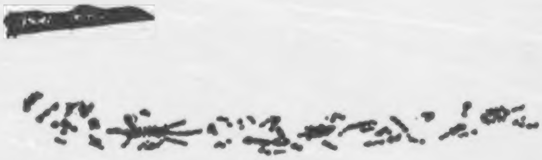
1. Some scientists believe petroleum formations began ____ of years ago, when tiny ____ creatures abounded in and near the ____ as they do today.



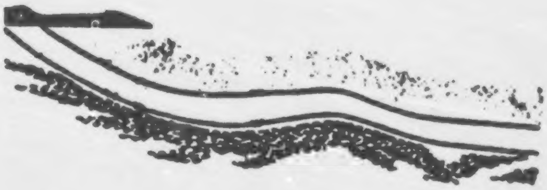
2. As marine life died, it ____ to the sea bottom and became buried in ____ of mud and sand.



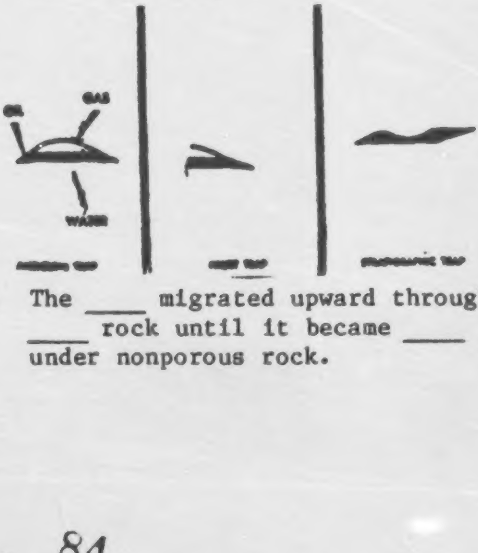
3. The ____ matter held in mud and silt was changed to gas and oil probably by gradual decay, ____, ____ and possible bacterial and radioactive actions.



4. As millions of years passed, ____ compressed the deeply buried layers of mud, silt and sand into layers of ____.



5. ____ and other earth forces caused the rock ____ to become ____ and ____.



6. The ____ migrated upward through ____ rock until it became ____ under nonporous rock.

Student Worksheet

THE GENESIS OF OIL AND NATURAL GAS

ANSWER SHEET

1. Some scientists believe petroleum formations began millions of years ago, when tiny marine creatures abounded in and near the sea as they do today.

2. As marine life died, it settled to the sea bottom and became buried in layers of mud and sand.

3. The organic matter held in mud and silt was changed to gas and oil probably by gradual decay, heat, pressure and possible bacterial and radioactive actions.

4. As millions of years passed, pressure compressed the deeply buried layers of mud, silt and sand into layers of rock.

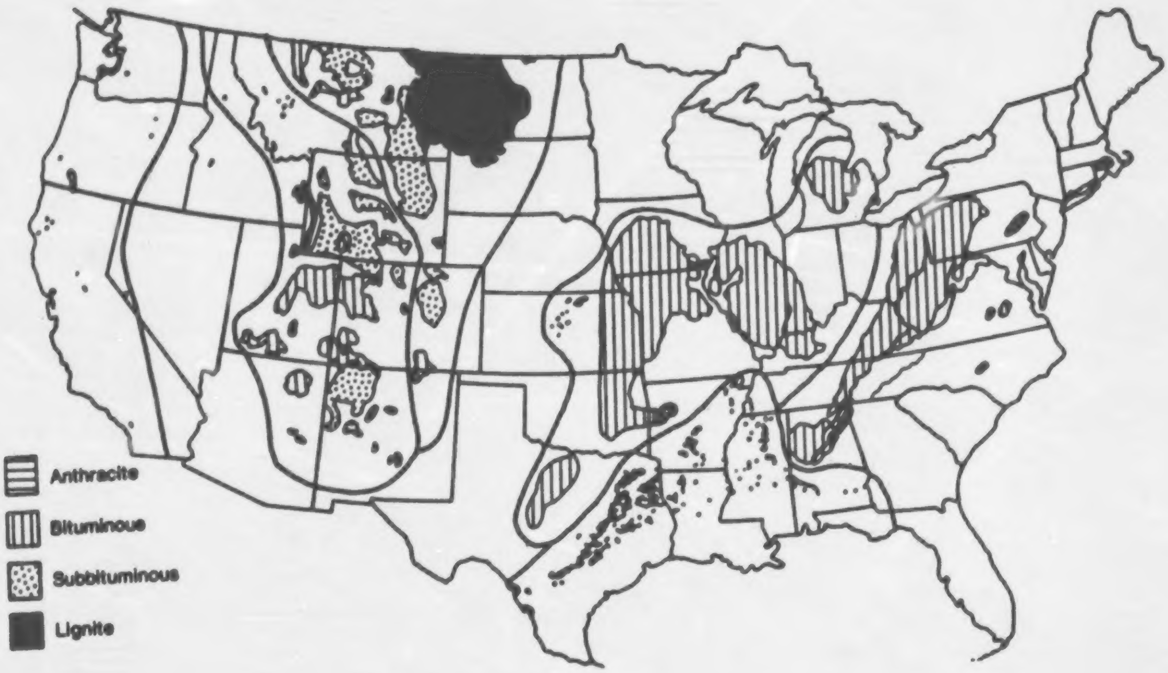
5. Earthquakes and other earth forces caused the rock layers to become buckled and twisted.

6. The petroleum migrated upward through porous rock until it became trapped under non-porous rock.

Student Worksheet

DISTRIBUTION OF FOSSIL FUEL RESOURCES IN THE UNITED STATES

Coal fields in the United States



SOURCE: Bureau of Land Management

Answer the following questions about the maps:

1. Name the counties in Arkansas where coal, oil and natural gas fields are located.

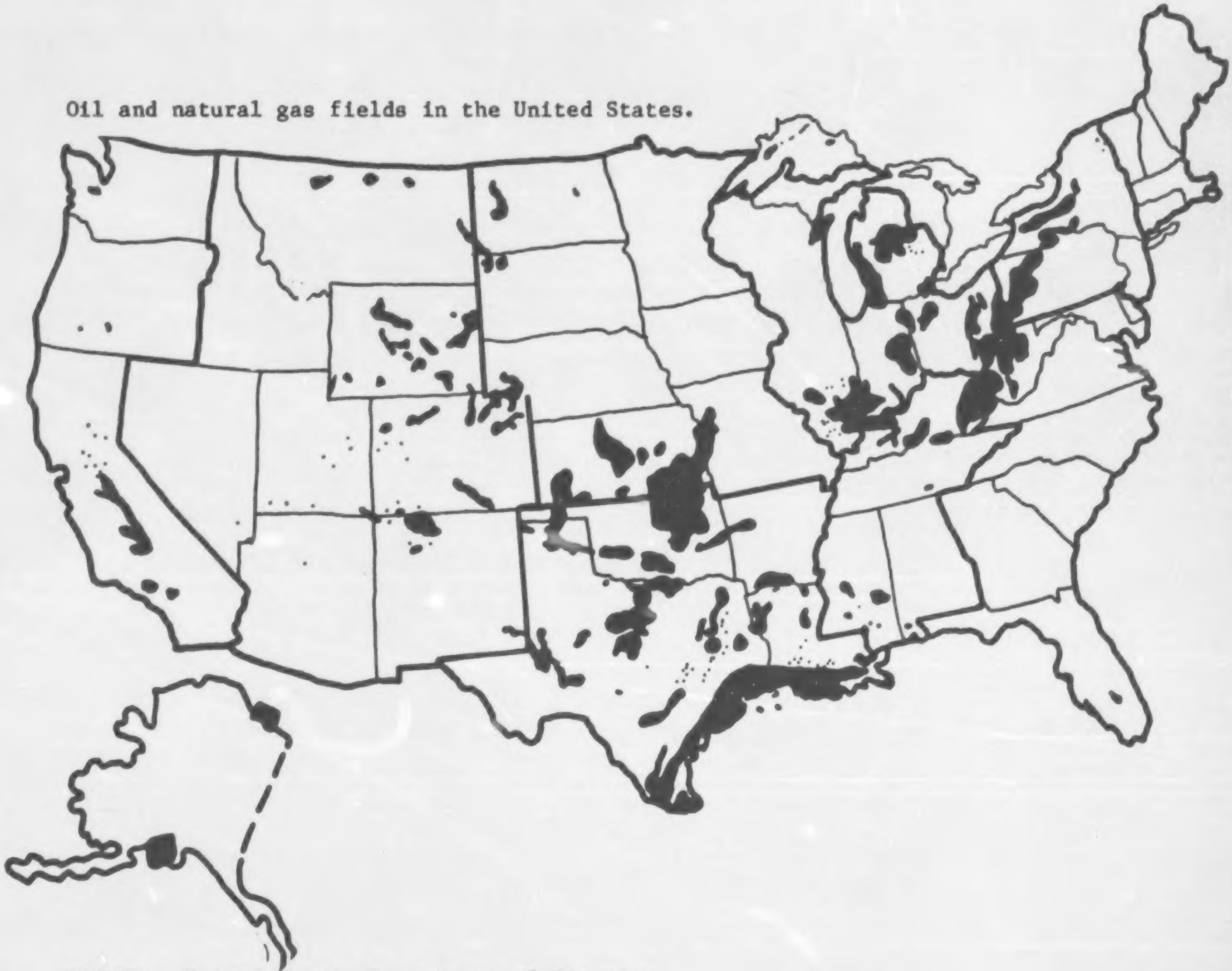
2. From looking at the two maps, state whether or not you think coal, oil and/or natural gas will be important in Arkansas' energy future.

3. How does Arkansas' coal, oil and/or natural gas future compare to that of some of the other states?

Student Worksheet

DISTRIBUTION OF FOSSIL FUEL RESOURCES IN THE UNITED STATES

Oil and natural gas fields in the United States.



SOURCE: United States Department of Interior

4. Name the types of coal located in Arkansas.

5. Can you see a relationship among the locations of coal, oil and natural gas deposits in the United States? Explain.

6. The largest coal deposits in the United States are of what type?

Student Worksheet

ANSWER SHEET

1. Oil and gas resources: Sebastian, Franklin, Johnson, Pope, Conway, Crawford, Logan, Yell, Nevada, Hempstead, Lafayette, Columbia, Union, Ouachita, Calhoun, Bradley, Miller.

   Coal: Sebastian, Scott, Logan, Franklin, Yell, Conway, Perry, Crawford, Pope, Johnson.

2. All three will be important in Arkansas' energy future.

3. Arkansas has fewer coal deposits than the Western states with more lignite and less anthracite and bituminous. The states surrounding Arkansas to the West and the Great Lakes states have more oil and natural gas fields than Arkansas. Perhaps there will be future discoveries made in Arkansas.

4. Lignite, anthracite and bituminous.

5. They seem to cluster in certain areas. They are all fossil fuels formed under similar conditions from similar materials.

6. Bituminous.

Student Worksheet

THE MULTIMILLION-YEAR-OLD FUELS
OF THE TWENTIETH CENTURY

Most of the energy that runs our cars and trucks, buses and subways, railroads and airplanes; that heats and cools and lights our houses, offices, schools, and stores; that runs our appliances; that turns the wheels of industry - comes from three fossil fuels called petroleum or oil, coal, and natural gas. How much do you know about them? First of all they are called fossil fuels because they were formed from the remains of ancient plants and animals buried under layer upon layer of sand, mud, and water over hundreds of millions of years. Pressure and heat and the passage of time changed the fossil remains in different ways to oil, natural gas and coal. Test yourself on this page to see what else you know about fossil fuels.

Circle the Answer:

1. In 1979, natural gas supplied (a) about one-quarter; (b) most; (c) very little of this nation's energy.

2. In 1979, petroleum supplied (a) almost all; (b) about half; (c) very little of this nation's energy.

3. In 1979, coal supplied (a) the most; (b) the least; (c) about half of this nation's fossil fuel energy.

4. The average distance of a natural gas well drilled into the ground is (a) 100 feet; (b) 1,000 feet; (c) one mile.

5. Coal is found (a) near the surface of the earth; (b) many hundreds of feet underground; (c) both of these.

True or False:

6. ____T ____F All fossil fuels must be burned to obtain energy.

7. ____T ____F The United States, which has less than 1/16 of the world's population, uses 1/3 of the world's energy supplies.

8. ____T ____F In 1979, the United States supplied most of its own oil and bought very little from other nations.

9. ____T ____F The automobile is the single largest user of petroleum products.

10. ____T ____F Petroleum, coal, and natural gas are used to make aspirin tablets, food preservatives, nylon stockings, and fertilizers.

Student Worksheet

THE MULTIMILLION-YEAR-OLD FUELS OF THE TWENTIETH CENTURY

ANSWER SHEET

Most of the energy that runs our cars and trucks, buses and subways, railroads and airplanes; that heats and cools and lights our houses, offices, schools, and stores; that runs our appliances; that turns the wheels of industry - comes from three fossil fuels called petroleum or oil, coal, and natural gas. How much do you know about them? First of all they are called fossil fuels because they were formed from the remains of ancient plants and animals buried under layer upon layer of sand, mud, and water over hundreds of millions of years. Pressure and heat and the passage of time changed the fossil remains in different ways to oil, natural gas and coal. Test yourself on this page to see what else you know about fossil fuels.

Circle the Answer:

1. In 1979, natural gas supplied [✓ (a) about one-quarter]; (b) most; (c) very little of this nation's energy.
2. In 1979, petroleum supplied (a) almost all; [✓ (b) about half]; (c) very little of this nation's energy.
3. In 1979, coal supplied (a) the most; [✓ (b) the least]; (c) about half of this nation's fossil fuel energy.
4. The average distance of a natural gas well drilled into the ground is (a) 100 feet; (b) 1,000 feet; [✓ (c) one mile].
5. Coal is found (a) near the surface of the earth; (b) many hundreds of feet underground; [✓ (c) both of these].

True or False:

6. X T ____ F All fossil fuels must be burned to obtain energy.
7. X T ____ F The United States, which has less than 1/16 of the world's population, uses 1/3 of the world's energy supplies.
8. ____ T X F In 1979, the United States supplied most of its own oil and bought very little from other nations.
9. X T ____ F The automobile is the single largest user of petroleum products.
10. X T ____ F Petroleum, coal, and natural gas are used to make aspirin tablets, food preservatives, nylon stockings, and fertilizers.

Student Worksheet

THE MULTIMILLION-YEAR-OLD FUELS
OF THE TWENTIETH CENTURY

Check the Boxes:

11. Fossil fuels have some attractive qualities. Check those you agree with.

_____ They are easy to get from the ground.
_____ They have a high energy content and can do more work than most other energy sources.
_____ They are easily transported from one place to another.
_____ Until a few years ago, they were cheap and plentiful.
_____ Because of their use, people's lives became easier and more comfortable.

12. Check the kinds of problems caused by burning oil and coal.
_____ Air pollution.
_____ Water pollution.
_____ Land destruction.
_____ Waste products.
_____ Noise pollution.

13. A person working hard for two years equals the energy given off by:
_____ One barrel of oil.
_____ 420 pounds of coal.
_____ 5,082 cubic feet of natural gas.
_____ Each of these.

14. Match the fossil fuel with its most important use:

Coal	Generation of electricity
Petroleum	Heating of houses and stores
Natural gas	Transportation

15. If we used only the petroleum, coal and natural gas that could be produced in the United States, and used it in the same amounts each year that we do now, without finding new sources, (according to some estimates) about how long would our supply of each last?

Coal	60- 80 years
Petroleum	300-500 years
Natural gas	40- 60 years

16. Is there any way we can help create new supplies of fossil fuels?

Student Worksheet

THE MULTIMILLION-YEAR-OLD FUELS
OF THE TWENTIETH CENTURY

ANSWER SHEET

Check the Boxes:

11. Fossil fuels have some attractive qualities. Check those you agree with.

X They are easy to get from the ground.
X They have a high energy content and can do more work than most other energy sources.
X They are easily transported from one place to another.
X Until a few years ago, they were cheap and plentiful.
X Because of their use, people's lives became easier and more comfortable.

12. Check the kinds of problems caused by burning oil and coal.

X Air pollution.
X Water pollution.
X Land destruction.
X Waste products.
X Noise pollution.

13. A person working hard for two years equals the energy given off by:

X One barrel of oil.
X 420 pounds of coal.
X 5,082 cubic feet of natural gas.
X Each of these.

14. Match the fossil fuel with its most important use:

Coal → Generation of electricity
Petroleum → Transportation
Natural gas → Heating of houses and stores

15. If we used only the petroleum, coal and natural gas that could be produced in the United States, and used it in the same amounts each year that we do now, without finding new sources, (according to some estimates) about how long would our supply of each last?

Coal → 300-500 years
Petroleum → 60- 80 years
Natural gas → 40- 60 years

16. Is there any way we can help create new supplies of fossil fuels?
Only by conserving what we have.

LESSON #6

CATEGORY: Sources

TITLE: Coal and Lignite in Arkansas

INFUSE WITH SUBJECT AREA:
Science
Reading
Social Studies

ENERGY TYPE: Coal, lignite

GRADE LEVEL: 8-12

TIME NEEDED: One period

MATERIALS:

Optional:
Class set of booklets: "Arkansas Energy Future: "Coal" and "Arkansas Energy Future: Lignite."

OBJECTIVES:

1. The students will become familiar with the history, uses, types and locations of coal and lignite in Arkansas.
2. The students will be aware of problems and impacts involved in the development of Arkansas coal and lignite, and be able to offer possible solutions to problems.

TASK ANALYSIS:

The students should be able to read maps and charts; read written material and answer questions from it.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 6.3 - 6.9.
   Read Student Background Information (6.3 - 6.6).
   Gather above listed booklets from the Arkansas Energy Office, 3000 Kavanaugh Boulevard, Little Rock, AR 72205.

2. Steps in Lesson
   Objective #1: The students will become familiar with the history, uses, types and locations of coal and lignite in Arkansas.

   a. Hand out Student Worksheets 6.3 - 6.7. Have the students read the Background Information and answer the questions. Discuss the answers in class.

   Objective #2: The students will be aware of problems and impacts involved in the development of Arkansas coal and lignite, and be able to offer possible solutions to problems.

   a. Hand out Student Worksheet 6.8. Answer the questions during class discussions.

b. Hand out Student Worksheet 6.9. Let the students brainstorm solutions to these problems, either as one group or several smaller groups.

3. Evaluation

Check answers to Student Worksheets.
Make oral evaluations during student brainstorming sessions.

4. Follow-Up Activities

Trace the coal formation cycle from peat through graphite.

Have students research coal mining and extraction methods, and use their findings to make a model of a coal mine.

Have students research coal mining methods that have been used in Arkansas, and make either a bulletin board or an oral report from their findings.

Collect samples of Arkansas coal including lignite, anthracite and bituminous. Observe the differences between the types by carefully examining them with a hand lens and answering the following questions:

-Which sample looks most like plants?
-Which sample looks least like plants?
-Arrange the samples in order of hardness.
-Arrange the samples in order of luster or shine.
-Which sample looks like it has the most carbon in it?
-Which sample looks like it has very little carbon in it?

Now hold each sample with tongs and light it with the bunsen burner. Note how long each takes to ignite. Also, note any odors or smoke and how rapidly each burns.

Have students debate the positive and negative aspects of surface (strip) mining.

STUDENT BACKGROUND INFORMATION

Sources:

Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

"Arkansas Energy Future: Coal." Arkansas Department of Energy: Little Rock. 1980.

"Arkansas Energy Future: Lignite." Arkansas Department of Energy: Little Rock. 1980.

Coal has not been a significant part of the Arkansas energy mix in the recent past, but with the dwindling national supplies of oil and natural gas, coal will probably become an increasingly important component of the state's fuel mix. The principal use of coal in energy production in Arkansas will likely be the generation of electricity. Since the summer of 1978 there has been one power plant in the state fueled by coal -- The Flint Creek Plant in Benton County; now one unit of the White Bluff plant in Jefferson County is in operation. At least one additional coal-fueled and one lignite-fueled power plant are planned to become operational in the state in the 1980's and early 1990's. Due to the large capacities of the coal and lignite fueled power plants, the percentage of coal-fueled electrical generating capacity in Arkansas will increase significantly in the 1980's. By the early 1990's almost half of the state's electrical generating capacity could be fueled by coal and lignite.

Arkansas is a coal producer, but a minor one when compared with many of the other coal-producing states. With reserves estimated variously at 400 million to one billion tons (not including lignite). Arkansas coal represents a strong potential for increased energy development.

The important elements of coal are water, *volatile gases*, fixed carbon, ash, and sulfur. The volatile gases and fixed carbons are fuel elements, water, ash, and sulfur are considered waste. The higher rank (harder) coals are classified according to fixed carbon: the lower rank (soft) coals according to their heat value.

Coal Seam exposed in the Atoka Formation in Johnson Co.

Large-scale mining of the state's coal began about 1870, peaked in 1907 and has declined since the early 1950's.

Dragline extracting coal from Peabody Mines, Johnson Co.

Coal Mining operation near Fort Smith

A large portion of Arkansas' coals are of metallurgical (high) quality and are exported to out-of-state markets for steel mill and other metallurgical uses, thus not entering the Arkansas fuel mix. Lower grade coal is imported by rail from Wyoming because it is cheaper than Arkansas coal, but also because it is low-sulfur coal whereas Arkansas coal is classified as high-sulfur.

Average Analysis of Coal Beds in the Arkansas Coal Field

(As Received)

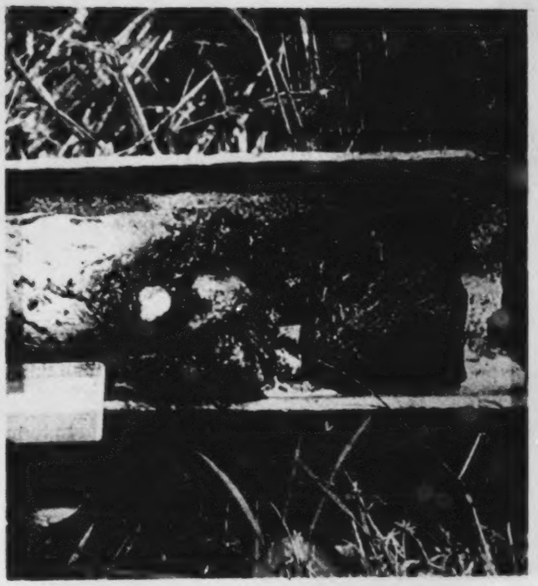
Coal Bed	No. of Samples	County	% Moisture	% Volatile Matter	% Fixed Carbon	% Ash	% Sulfur	BTU
Charleston	(5)	Franklin Sebastian	2.4	18.2	74.0	5.5	2.6	14,363
Paris	(43)	Franklin Logan	1.8	17.9	70.6	9.8	4.4	13,765
Atoka	(3)	Johnson Pope	1.4	13.8	77.2	7.6	3.4	14,070
Lower Hartshorne	(125)	Scott Sebastian	2.9	17.4	72.1	7.7	1.3	13,771
Lower Hartshorne	(68)	Franklin Johnson	3.0	13.5	75.9	7.6	1.8	13,854
Lower Hartshorne	(14)	Logan Pope	2.8	12.0	75.7	9.6	1.7	13,499

Data Source:
Arkansas Geological Commission

Until recently, little attention was given to the lignite deposits in Arkansas. Lignite, a brownish-black coal that still bears plant fragments, was mined in Arkansas intermittently from the 1860's to 1945 and used for domestic fuel, a source of dye and distilled oil. With the declining supply of natural gas and the need to reduce dependence on foreign oil, the potential that lignite offers Arkansas as a major domestic fueled source has been recognized.

Typical small seam denoting the sometimes high sulfur content. Johnson Co.

Lignite seams found in Hot Springs County near Malvern.



Cored section of lignite showing carbon rich clay layered with lignite.

Since Arkansas lignite has an average heating value of 6,000 BTU per pound -- about half the heating value of Wyoming coal -- the estimated reserves represent an energy equivalent of almost eight billion barrels of oil. Although lignite must be mixed with higher-grade coal for use in conventional coal-fueled power plants, lignite can be the sole fuel in plants with boilers specifically designed for its fuel characteristics. Arkansas lignite is generally considered a viable fuel alternative to Wyoming coal for needed electrical generation in the post-1985 time frame.

In 1979, Arkansas Power and Light Company (AP&L) and Arkansas Electric Cooperative Corporation (AECC) announced plans for the construction of a lignite mine and a two unit, lignite fueled power plant in Calhoun County that will cost an estimated 1.8 billion dollars (in 1988 dollars). The mine and power plant will comprise what will be known as the Arkansas Lignite Energy Center.

When Arkansas lignite reserves are developed, substantial benefits could accrue to the area's economy. Rather, than dollars flowing out-of-state for the pruchase of coal, the money will stay in Arkansas and, through the multiplier effect, stimulate general economic development in south Arkansas. Benefits could include an expanded and diversified economic base, a larger tax base, in-migration of skilled labor, increased personal income, and an increased energy supply. It is estimated that the net economic benefits to the Arkansas economy of the Arkansas Lignite Energy Center will be over 150 million dollars.

The intent of the Arkansas Surface Coal Mining and Reclamation Act of 1979 was to "Assure that surface coal mining operations are so conducted as to protect the environment." Lignite falls under the definition of coal in this Act. Some major features of this law include: 1) in order to obtain a mining permit, mine operators are required to prove before-hand that they can reclaim the land, and must post a bond, the amount of which will be sufficient to assure reclamation; and 2) the land must be restored so that it can be used for the same purposes as it was utilized before mining. Such restoration includes filling in holes, contouring the land to its original shape, preserving all soil, removing all wastes, and replanting the land with grasses and trees. If interpreted and enforced strictly, and adequately funded, this law could go a long way to protect valuable ecosystems from the effects of the surface mining of Arkansas' coal and lignite.

Drill operated by Arkansas Geological Commission Ouachita County in search for valuable lignite seams.

Reclaimed land owned by Peabody Coal Co. Johnson Co.

With the days of abundant oil and natural gas in the past and the potential for renewable energy resource use still in the future, the demand for coal and lignite will continue to rise. Every recent estimate for coal and lignite production points in this direction. With the demand for coal and lignite expected to increase by approximately 5 percent annually, their share of the nation's annual energy supply (currently 19 percent of the total) is expected to increase for the first time since the early 1900's. Arkansas will no doubt play an important part in the nation's future energy role. Arkansas lignite and its products could prove to be a competitive and reliable energy source by the mid-1980's.

Student Worksheet

ARKANSAS COAL AND LIGNITE

Answer the following questions.

1. Why is coal becoming more important to the Arkansas energy picture?
2. The main use of coal in Arkansas energy production will probably be ________ ____
3. About 99% of the coal mined in Arkansas comes from what six counties?
4. What advantages does Wyoming coal have over Arkansas coal?
5. What industry uses much of Arkansas' coal?
6. Why was Arkansas lignite often ignored in the past?
7. What is the Arkansas Lignite Energy Center?
8. What effect will the development of Arkansas lignite have on Arkansas' economy?
9. What was the purpose of the Arkansas Surface Coal Mining and Reclamation Act of 1979.
10. Name two Arkansas companies that have an interest in the development of lignite.

Student Worksheet

ARKANSAS COAL AND LIGNITE
ANSWER SHEET

1. Easy, cheap supplies of oil and natural gas are running out.

2. Electricity.

3. Franklin, Johnson, Logan, Pope, Scott and Sebastian. Crawford also contributes a small amount.

4. Cheaper; low sulfur content.

5. Steel.

6. High moisture content; low grade with low heat value.

7. Arkansas Power and Light Company's proposed two unit, lignite fueled power plant in Calhoun County.

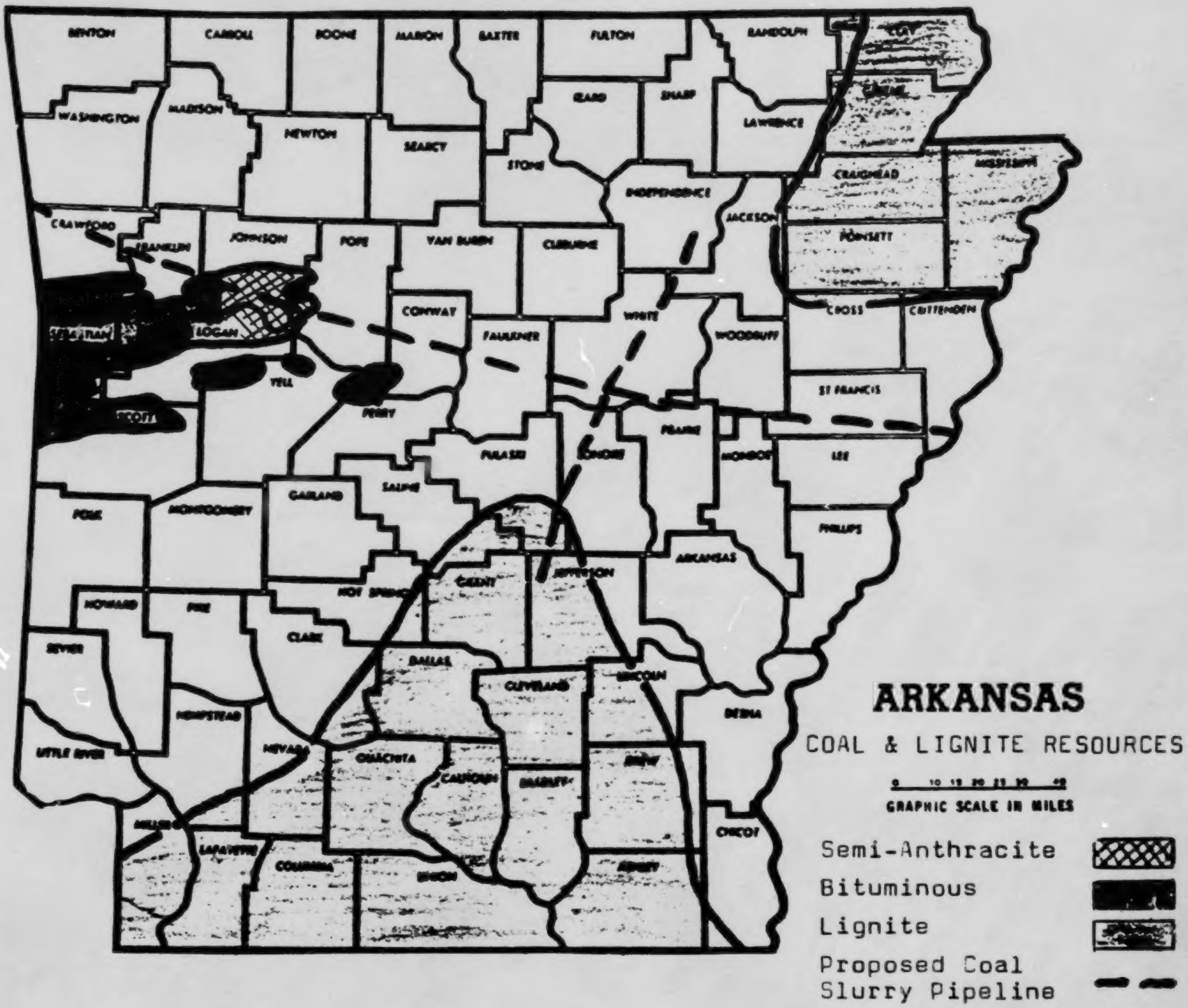
8. General economic development in south Arkansas should be stimulated.

9. To assure that surface coal mining operations would be conducted in such a way as to protect the environment.

10. Arkansas Power and Light Company; Arkansas Electric Cooperative Corporation.

Student Worksheet

COAL AND LIGNITE LOCATIONS


ARKANSAS
COAL & LIGNITE RESOURCES
GRAPHIC SCALE IN MILES
Semi-Anthracite ▨
Bituminous ■
Lignite ▒
Proposed Coal Slurry Pipeline ▬ ▬
BENTON
CARROLL
BOONE
MARION
BAXTER
FULTON
RANDOLPH
CLAY
WASHINGTON
MADISON
NEWTON
SEARCY
STONE
IZARD
SHARP
LAWRENCE
GREENE
CRAIGHEAD
MISSISSIPPI
INDEPENDENCE
JACKSON
POINSETT
CRAWFORD
FRANKLIN
JOHNSON
POPE
VAN BUREN
CLEBURNE
SEBASTIAN
LOGAN
CONWAY
FAULKNER
WHITE
WOODRUFF
CROSS
CRITTENDEN
YELL
PERRY
SCOTT
ST FRANCIS
PULASKI
LONOKE
PRAIRIE
MONROE
LEE
POLK
MONTGOMERY
GARLAND
SALINE
PHILLIPS
GRANT
JEFFERSON
ARKANSAS
HOWARD
PIKE
HOT SPRING
CLARK
SEVIER
DALLAS
CLEVELAND
LINCOLN
DESHA
HEMPSTEAD
LITTLE RIVER
NEVADA
OUACHITA
CALHOUN
BRADLEY
DREW
MILLER
LAFAYETTE
COLUMBIA
UNION
ASHLEY
CHICOT

Answer the following questions:

1. What areas of Arkansas contain the most coal, oil and natural gas deposits?

2. If your county is one of these areas, list problems that might be expected to arise resulting from the development and use of the deposits.

3. If your county is not one of the areas, list problems that might arise from lack of these deposits nearby.

Student Worksheet

COAL AND LIGNITE LOCATIONS
ANSWER SHEET

1. Anthracite and bituminous coal are located in the western Arkansas River Valley.
   Lignite is located in northeast, southcentral and southwest Arkansas.
   Gas fields are located in western Arkansas River Valley and southwest Arkansas.
   Oil fields are located in southwest Arkansas.

2. Answer varies with county

3. Answer varies with county.

Student Worksheet

PROBLEMS AND IMPACTS INVOLVED IN THE DEVELOPMENT OF ARKANSAS COAL AND LIGNITE

1. Coal is the most polluting fossil fuel. It emits dangerous toxic metal compounds, cancer causing radioactive substances, sulfur oxides and particulates when burned. These emissions contribute to repsiratory ailments and acid rains.

2. The burning of coal spews more carbon dioxide into the air per unit of heat released than any other fossil fuel or carbon-containing fuel. There is growing cocnern that increasing carbon dioxide concentrations in the atmosphere could eventually change global climate, with disastrous consequences for mankind.

3. In Arkansas, almost all the coal extracted is surface or strip mined, and probably all the lignite that will be recovered will be accomplished by the same methods.

4. Arkansas coals (which are high-sulfur) and lignite are now required to have scrubbers (which remove some of the emissions and particulates given off) if burned in power plants.

5. Arkansas coal seams are relatively thin (14 to 18 inches), and are generally not found in large tracts.

6. Arkansas lignite will primarily be used by "mine mouth" power plants. The power plant will be built as close as possible to the lignite mine, to reduce transportation costs.

7. Arkansas lignite has a low heating value and a tendency toward spontaneous combustion when shipped; therefore, the use of lignite in Arkansas will be largely restricted to localities of occurence.

8. The lignite reserves around Hampton in Calhoun County are sufficient to fuel the Arkansas Lignite Energy Center for thirty years. This span will be the expected life of the plant.

9. There are indications that rapid growth resulting from energy projects can create many socio-economic and environmental problems. An influx of people into the lignite development areas could strain existing social and economic structures. A "boom town" situation could be created.

10. Lignite mining could have significant adverse effects on both surface and ground water. Mining could pollute the streams with silt or chemical waste, lower the water table and have a negative effect on wildlife habitats.

LESSON #7

CATEGORY: Sources

ENERGY TYPE: Petroleum,
Natural Gas

TITLE: Oil and Natural Gas in Arkansas

GRADE LEVEL: 8-12

INFUSE WITH SUBJECT AREA:
Science
Reading
Social Studies

TIME NEEDED: Two periods

MATERIALS:
None

OBJECTIVES:

1. The students will become familiar with the use, history, location, production and future of oil in Arkansas.
2. The students will become familiar with the problems of oil use in Arkansas.
3. The students will become familiar with the production and use of natural gas in Arkansas.
4. The students will recognize the locations of Arkansas oil and natural gas transportation pipelines.
5. The students will be familiar with problems that might occur as a result of oil and natural gas pipelines that cross the state.
6. The students will make a comparison of Arkansas-related oil and natural gas.

TASK ANALYSIS:

The students should be able to read pie graphs; and read and answer questions from written work sheets.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 7.4 - 7.11.

2. Steps in Lesson
   Objective #1: The students will become familiar with the use, history, location, production and future of oil in Arkansas.

   a. Hand out Student Worksheets 7.4 - 7.10. Have students read the Background Information and answer the questions.
   b. Answer the questions on Student Worksheet 7.7 as a group.

   Objective #2: The students will become familiar with the problems of oil use in Arkansas.

   a. Review Student Worksheet 7.5. Have the students check the oil problems they feel pertain to Arkansas. Ask them to be ready to state the reasoning behind their answers. Discuss the answers in class.

Objective #3: The students will become familiar with the production and use of natural gas in Arkansas.

a. Review Student Worksheets 7.5 - 7.6. Discuss the background material on these sheets as a group.

Objective #4: The students will recognize the locations of Arkansas oil and natural gas transportation pipelines.

a. Referring to Student Worksheet 7.10, answer the following questions:
   -In what areas of Arkansas do the pipelines that carry intrastate natural gas and oil concentrate? (Southwest; Arkansas River Valley)
   -Where do the pipelines that are involved in interstate transmission occur?
   (Diagonally Southwest to Northeast across the center of the state; Southeast)

Objective #5: The students will be familiar with problems that might occur as a result of oil and natural gas pipelines that cross the state.

a. Have the students answer the following question as a group:
   What are some problems that could occur from the passage of natural gas and oil pipelines across Arkansas?
   (Breakage-explosion, harm life forms and environment; while building the line there might be damage or destruction of wildlife and habitat; in times of high utility costs, some poeple might commit acts of piracy against the lines).
b. Hand out Student Worksheet 7.11. Ask for comments, then have students answer the questions about the cartoon.

Objective #6: The students will make a comparison of Arkansas-related oil and natural gas.

a. Put the following chart on the chalkboard and have the students research answers to it:

Fuel	Use	Amount Imported	Reserves	Environmental Impact
Natural Gas				
Oil				

(Natural gas provides one-third of Arkansas' total energy, while oil provides fifty-six percent of the total. Seventy percent of Arkansas' natural gas is imported, while two-thirds of Arkansas' oil is imported.

Arkansas has more than 5,000 trillion cubic feet of reserve natural gas, and 372,337,000 barrels of reserve oil.

Natural gas is relatively clean and convenient to use, while oil is the most significant Arkansas air polluter in terms of volume of use.)

b. Ask for opinions from the students on which of the two they feel offers the most to the energy future of Arkansas.

3. Evaluation

Check answers to Student Worksheets

4. Follow-Up Activities

Take a field trip to any natural gas or oil pipeline located in your area.

STUDENT BACKGROUND INFORMATION

Sources:

Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

Arkansas Energy Office. Little Rock.

WHEE!
OIL
STOP

Contemporary Arkansas, like the nation, runs on oil and natural gas. The source of almost ninety percent of the state's primary energy (which does not include electricity) is oil and natural gas. Such dependency on these two fuels has resulted in one of the most difficult problems facing Arkansas today: there is simply not enough cheap oil and natural gas. The easily accessible and extractable oil and natural gas resources of the globe will, according to most knowledgeable sources, be depleted in a relatively brief time into the future. Just when depends on many supply and demand variables. What is certain is that, with expected increased demand and decreased supply, the oil and natural gas "joyride" that has characterized our society for the past few decades is drawing to a halt.

Petroleum Products

Crude oil production began in Arkansas in 1921 and attained peak production in 1925. There has been a steady decline in Arkansas production since the early 1960's, largely due to slowed down exploration efforts because of low cost foreign oil. Oil production in Arkansas is confined to eight counties in south Arkansas: Bradley, Calhoun, Columbia, Lafayette, Miller, Nevada, Ouachita and Union.

Petroleum products constitute approximately fifty-three percent of the total energy used in Arkansas. Of this, about forty-two percent is gasoline. The rest is comprised of middle distillates, residual oils and liquid petroleum gases (mainly propane). Petroleum products dominate the transportation sector. They also represent twenty-five percent of the residential sector, thirty-two percent of the commercial sector and twenty-two percent of the industrial sector.

Only twenty-eight percent of the petroleum products consumed in Arkansas is produced within the state. The balance of the state's oil requirements is satisfied from out-of-state domestic and foreign sources.

The consumption of petroleum products in Arkansas is about thirty-three barrels per capita per year, which is about equal to the national per capita annual consumption. But in gasoline consumption per capita, and per registered motor vehicle, Arkansas is above the national average. In recent years Arkansas has ranked at or near the top of all the states in gasoline use per capita and per registered motor vehicle.

What reasons can you think of for Arkansas' great gasoline usage?

The middle distillates, kerosene, diesel fuel and home heating oil, are the petroleum products that display the widest seasonal demand variations. Because these products are used prinicpally as space heating fuels, the demands are quite weather sensitive. The demand for gasoline is relatively constant throughout the year. Residual fuel oils are heavier fuel oils, and are used mainly in industry.

Familiar to many as "bottled gas," liquid petroleum gas (LPG) consists mainly of propane and butane. These highly volatile gases are extracted from refinery and natural gases. Arkansas is a disproportionately large user of propane. Arkansas in recent years has been the largest per capita user state, and near the top in total volume consumed of all states. Almost all the propane consumed in Arkansas is imported from out of state. Thus, Arkansas, with high per capita use of propane and almost completely dependent on out of state supplies, is quite susceptible to propane curtailment.

Can you think of some reasons why Arkansas is such a high user of propane?

Following is a list of problems caused by the use of oil. Check the ones you think pertain to Arkansas. Be ready to state your reasoning behind your answers.

_____ 1. Oil spills in the ocean.

_____ 2. Oil pollution of the world's waters from the disposal of waste oils from automobile crankcases and machines.

_____ 3. Contamination of air by burning oil.

_____ 4. Air pollution as a result of discharges from motor vehicles, fossil-fueled electric power plants and energy intensive industries.

_____ 5. Balance of payments crises due to the immense burden of foreign oil costs since 1973.

_____ 6. Danger of economic blackmail and unforeseen events that might cut off oil imports.

Two potential petroleum-bearing areas of Arkansas have recently received attention. Interest concentrates on certain rock formations north of the Arkansas River and in south Arkansas near the Desha Basin. Some people feel that we should get all of our oil out of the ground as quickly as possible, then shift from the widespread use of petrochemicals to more natural chemicals and products. Others feel that we should set aside a portion of our reserves of petroleum as raw materials to produce petrochemicals for future decades.

I'M DIGGING!
OVER MY Dead body!

Natural Gas

As a fuel, natural gas has many advantages, such as convenience of transportation and clean burning characteristics. The problem with natural gas is similar to that of oil, only more serious: there simply is not enough available to meet demands.

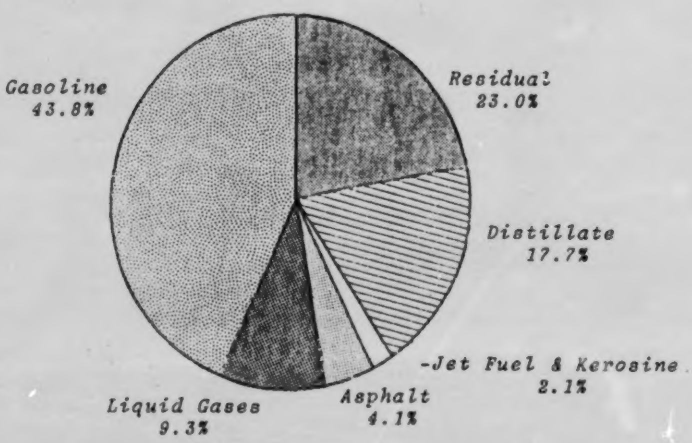
Natural gas has comprised approximately thirty percent of total Arkansas energy consumption in recent years. The natural gas use in Arkansas is above the national average; about forty-eight percent of the natural gas used in Arkansas is produced within the state. There are two natural gas producing regions in Arkansas, the Southwest and the Northwest.

Pipelines are used to transport natural gas and petroleum from the production fields within the state to both in- and out-of-state refineries and users. Pipelines also bring natural gas to Arkansas users from out-of-state sources, primarily Oklahoma, Texas and Louisiana. A third function of pipelines in Arkansas is interstate transmission of natural gas and petroleum. Some lines in this last category have few, if any, connections in Arkansas. They serve only to transport natural gas and oil across the state into other regions.

The supply of natural gas is running out, and although geologists expect additional discoveries, it is not epxected to be available as a major energy source in the United States for more than twenty years. Federal government controls have kept the price of natural gas artificially low. This has stifled the development of and competition from solar and other alternate energy sources, which have been more expensive to produce. Natural gas, therefore, has been and continues to be drastically overutilized.

The reserves of Arkla Gas Company, Southwestern Energy Company/Arkansas Western Gas Company of Fayetteville and Arkansas Oklahoma Gas Corporation of Fort Smith are considerably better than the national reserve average. These reserves assure Arkansas a natural gas supply for human needs customers for the near future, provided the federal government does not divert an inequitable amount of the natural gas available to other parts of the nation.

ARKANSAS CONSUMPTION OF PETROLEUM PRODUCTS
BY FUEL - 1978



Total 72,828 Thousand Barrels

SOURCE: Arkansas Energy Office

STUDENT BACKGROUND INFORMATION

ANSWER SHEET

Answers to questions found in reading material:

Why do Arkansans use so much gasoline?

Rural, dispered population who must travel farther for business and personal needs.
Lack of well-developed public transit systems.
Large areas of hilly topography.
More older cars, more trucks, fewer foreign cars; all of which tend to get lower miles per gallon of gasoline.
Milder winters, therefore, longer driving season.

Why do Arkansans use so much propane per capita?

Natural gas not available in rural areas and a large percentatge of Arkansans are rurally located.
Agricultural fuel for vehicles and buildings
Industrial fuel for vehicles and other machinery.

Oil use problems: All of these could pertain to Arkansas.

1. A large amount of oil used in Arkansas was produced by offshore drilling or transported from overseas by tankers.

2. More than two thirds of water pollution by oil comes from automobile crankcases and machines, of which Arkansas has a significant share. Arkansas has many streams to aid in carrying pollution to the oceans.

3. Oil is the most significant air polluter in Arkansas in terms of volume of use.

4. Arkansas contains motor vehicles, fossil-fueled electric power plants and energy intensive industries. Air pollution is almost entirely the result of a combination of these polluters. Arkansas also receives pollution from out of state.

5. Arkansas, as well as the rest of the nation, has been affected by monetary inflation, which stems from the devaluation of the dollar. Devaluation of the dollar is principally the result of a deficit international trade balance.

6. Two-thirds of Arkansas' oil comes from out-of-state domestic and foreign sources.

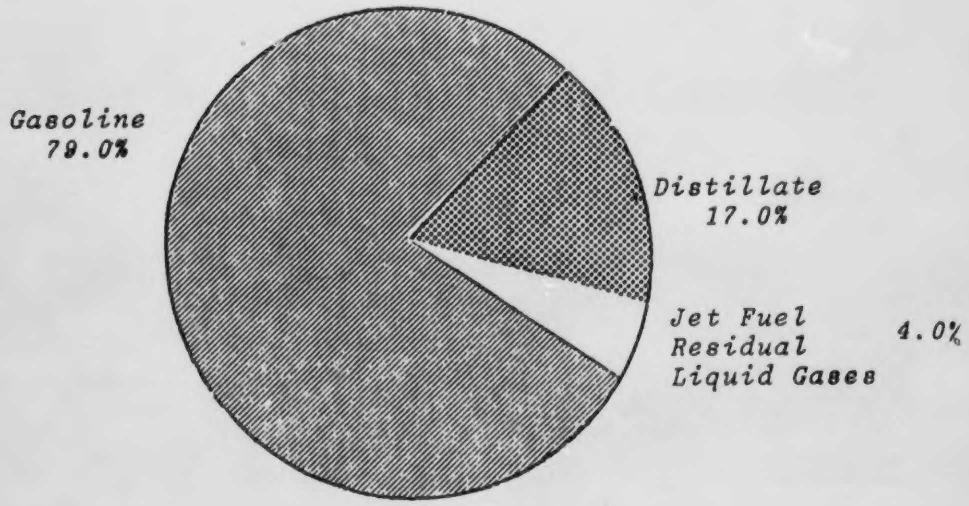
Student Worksheet

ARKANSAS OIL AND NATURAL GAS

Answer the questions from the Background Information and charts:

1. _____% of Arkansas' primary energy comes from oil and natural gas.
2. Why is the situation described in question #1 (above) a precarious one?
3. Why has oil production in Arkansas been declining?
4. What eight Southern Arkansas counties produce all the oil extracted in Arkansas?
5. How much of Arkansas' total oil is imported?
6. The most used petroleum product in Arkansas is ______________________________
7. Which Arkansas county is the largest gasoline user in Arkansas?
   Give some reasons.
8. To what gasoline use section (top, mid or low 25%) does your county belong?
   Do you agree with this placement?
   Why or Why not?
9. Name two Arkansas areas with potential for future oil development.
10. Should we mine our oil as quickly as possible or leave part of it in the ground as future reserves?

ARKANSAS PETROLEUM PRODUCT CONSUMPTION
1978
TRANSPORTATION SECTOR



Total Petroleum Products Consumed
By the Transportation Sector = 11,259,000 Thousand Barrels

Source: Arkansas Energy Office

Student Worksheet

ARKANSAS OIL AND NATURAL GAS
ANSWER SHEET

1. Ninety.

2. Contributing factor in causing oil and natural gas prices to rise; dependence on foreign oil; danger of oil or natural gas cutoff; not enough supply to meet demand.

3. Competition from low-cost, foreign oil.

4. Bradley, Calhoun, Columbia, Lafayette, Miller, Nevada, Ouachita and Union.

5. Two-thirds.

6. Gasoline.

7. Pulaski; largest population, industrial base, transportation fleet, etc.

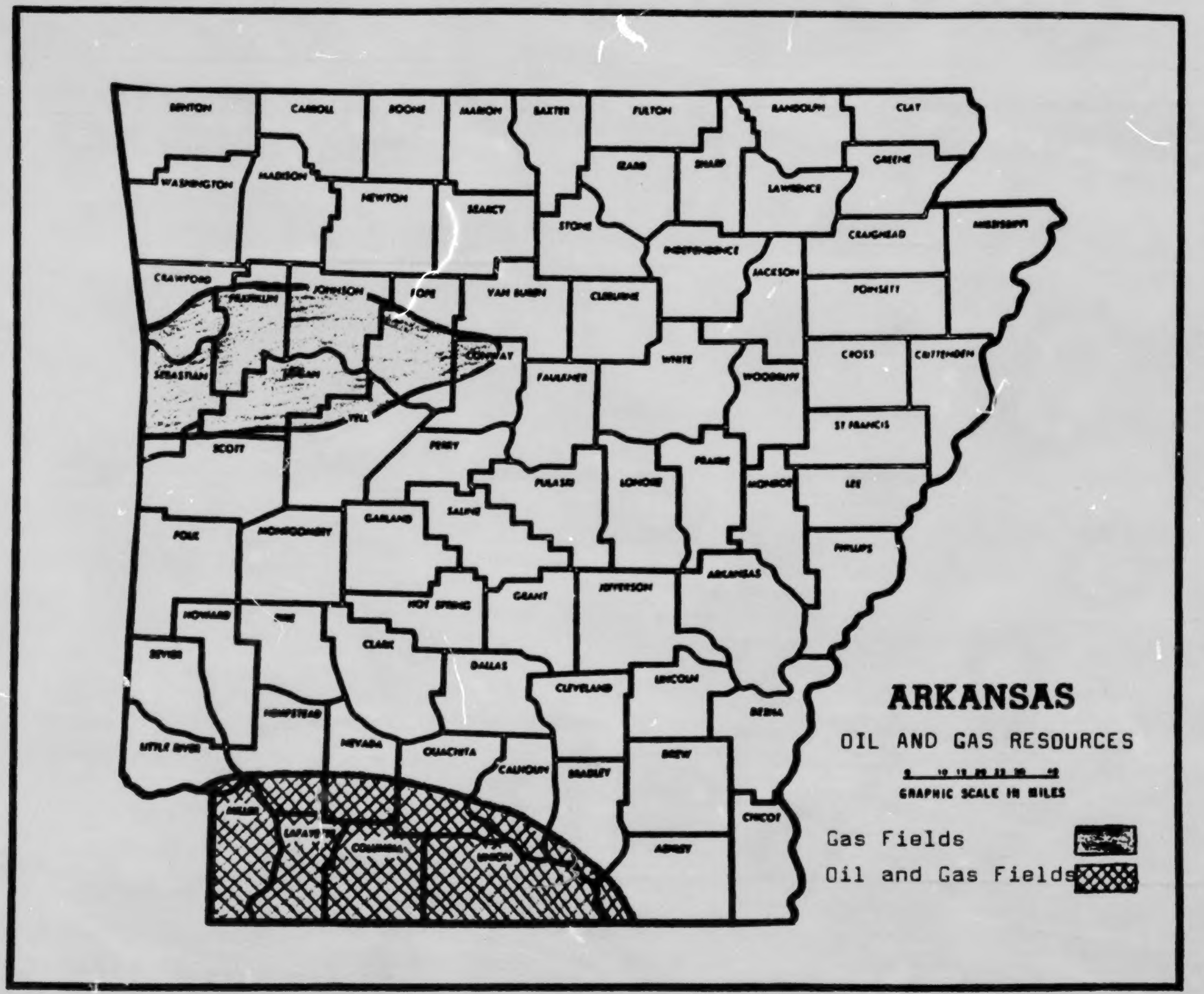
8. Depends on county.

9. Rock formations north of the Arkansas River; Southern Arkansas in the Desha Basin.

10. There are arguments for both sides. Perhaps part should be left to provide raw materials for petrochemicals in the future, but it can also be said that we should shift away from the use of petrochemicals as soon as possible.

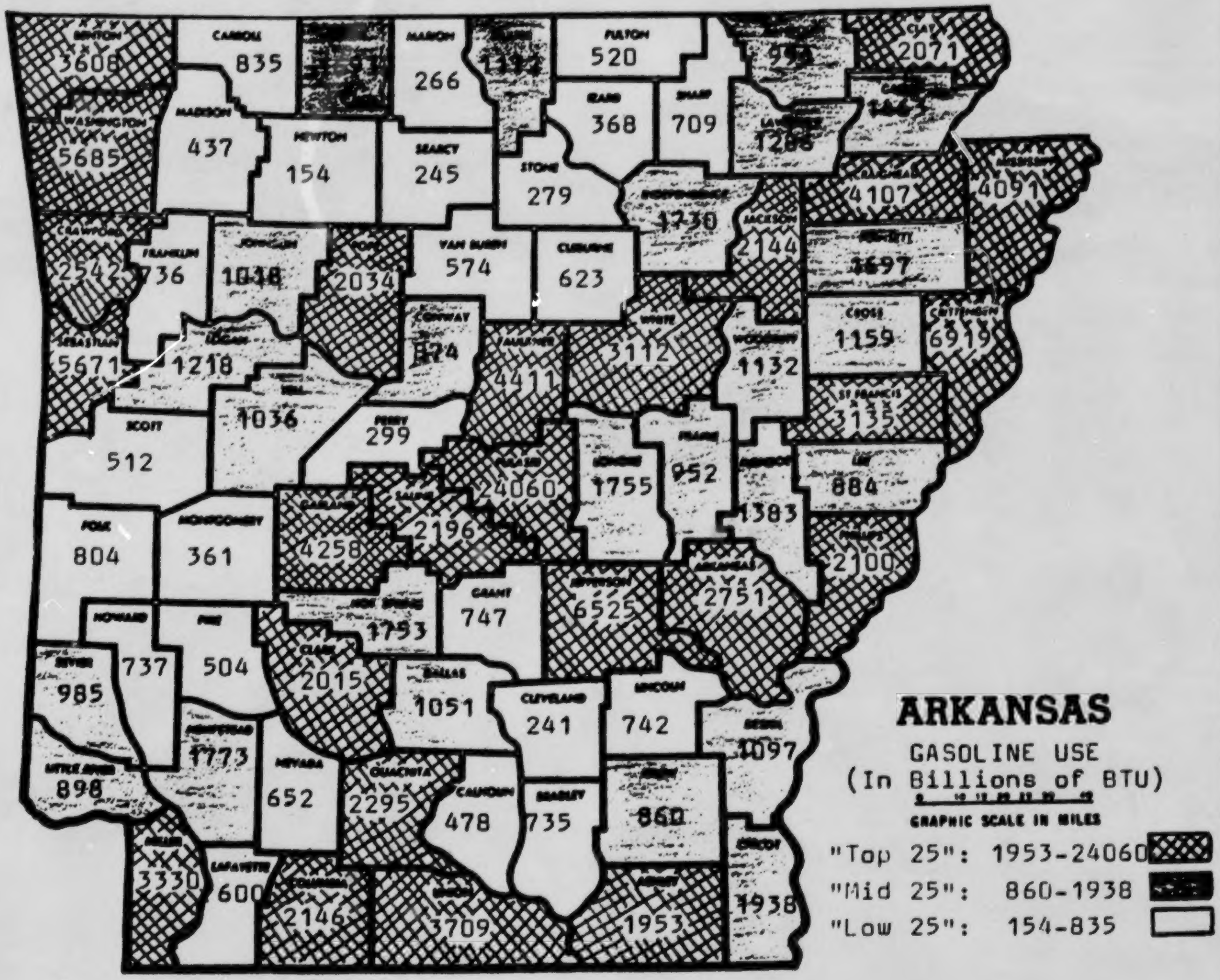
7.8

Student Worksheet


BENTON
CARROLL
BOONE
MARION
BAXTER
FULTON
RANDOLPH
CLAY
WASHINGTON
MADISON
NEWTON
SEARCY
IZARD
SHARP
LAWRENCE
GREENE
STONE
INDEPENDENCE
CRAIGHEAD
MISSISSIPPI
CRAWFORD
FRANKLIN
JOHNSON
POPE
VAN BUREN
CLEBURNE
JACKSON
POINSETT
SEBASTIAN
LOGAN
CONWAY
FAULKNER
WHITE
WOODRUFF
CROSS
CRITTENDEN
YELL
SCOTT
PERRY
ST FRANCIS
PULASKI
LONOKE
PRAIRIE
MONROE
LEE
POLK
MONTGOMERY
GARLAND
SALINE
PHILLIPS
ARKANSAS
HOT SPRING
GRANT
JEFFERSON
HOWARD
PIKE
CLARK
SEVIER
DALLAS
CLEVELAND
LINCOLN
HEMPSTEAD
DESHA
LITTLE RIVER
NEVADA
OUACHITA
CALHOUN
BRADLEY
DREW
CHICOT
MILLER
LAFAYETTE
COLUMBIA
UNION
ASHLEY
0 10 15 20 25 30 40
GRAPHIC SCALE IN MILES
Gas Fields
Oil and Gas Fields

ARKANSAS

OIL AND GAS RESOURCES


BENTON 3608
CARROLL 835
MARION 266
FULTON 520
CLAY 2071
WASHINGTON 5685
MADISON 437
NEWTON 154
SEARCY 245
IZARD 368
SHARP 709
1286
4107
4091
STONE 279
INDEPENDENCE 1730
JACKSON 2144
CRAWFORD 2542
FRANKLIN 736
JOHNSON 1018
POPE 2034
VAN BUREN 574
CLEBURNE 623
POINSETT 1697
CROSS 1159
CRITTENDEN 6919
SEBASTIAN 5671
LOGAN 1218
CONWAY 824
FAULKNER 4411
WHITE 3112
WOODRUFF 1132
ST FRANCIS 3135
YELL 1036
SCOTT 512
PERRY 299
PULASKI 24060
LONOKE 1755
PRAIRIE 952
MONROE 1383
LEE 884
POLK 804
MONTGOMERY 361
GARLAND 4258
SALINE 2196
PHILLIPS 2100
JEFFERSON 6525
ARKANSAS 2751
HOT SPRING 1753
GRANT 747
HOWARD 737
PIKE 504
SEVIER 985
CLARK 2015
DALLAS 1051
CLEVELAND 241
LINCOLN 742
DESHA 1097
HEMPSTEAD 1773
LITTLE RIVER 898
NEVADA 652
OUACHITA 2295
CALHOUN 478
BRADLEY 735
860
MILLER 3330
LAFAYETTE 600
COLUMBIA 2146
UNION 3709
ASHLEY 1953
CHICOT 1938
GRAPHIC SCALE IN MILES
"Top 25": 1953-24060 ▩
"Mid 25": 860-1938 ▨
"Low 25": 154-835 ☐

ARKANSAS

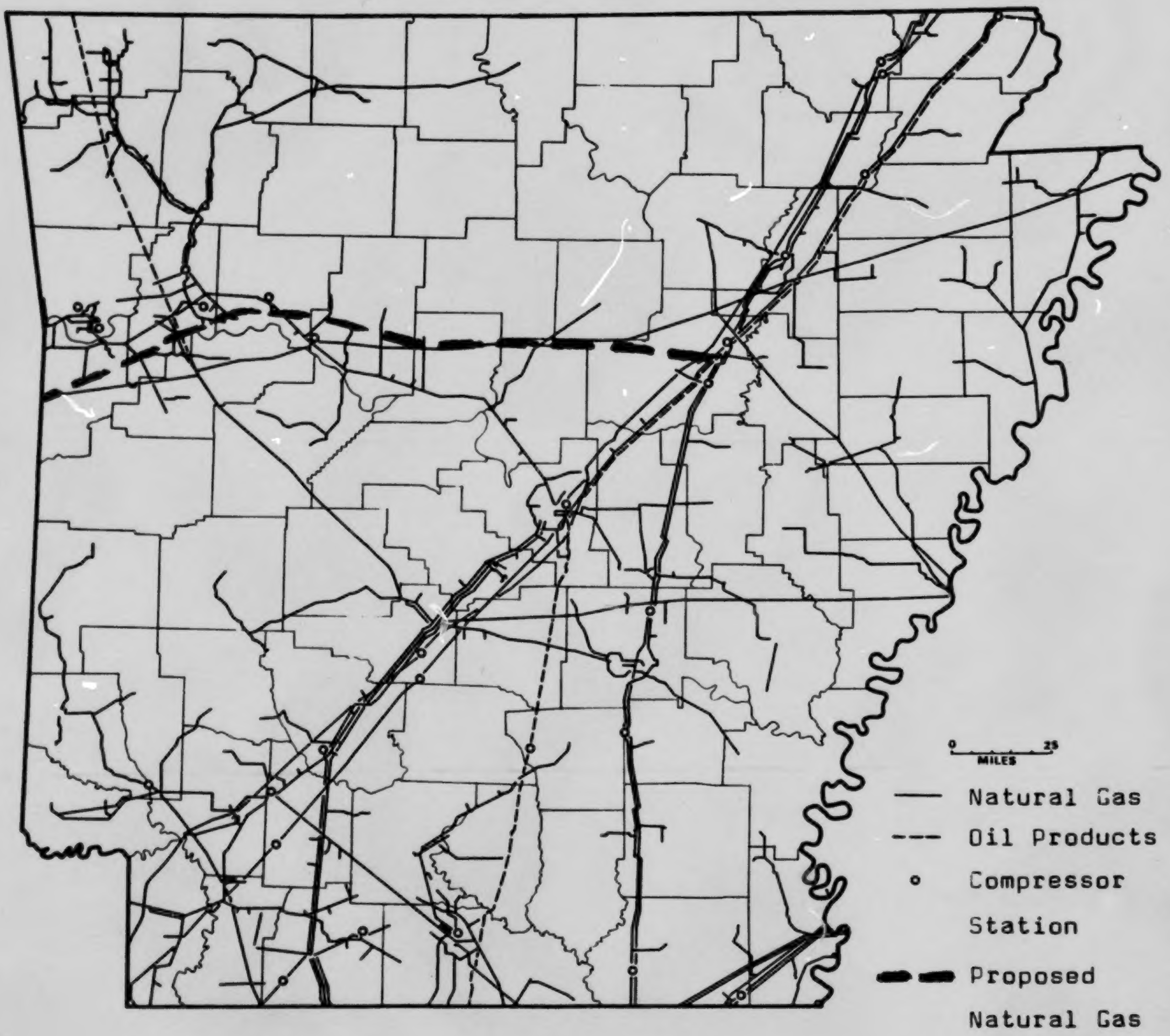
GASOLINE USE
(In Billions of BTU)

Data Source: Brookhaven National Laboratory

Data are for 1976

Student Worksheet

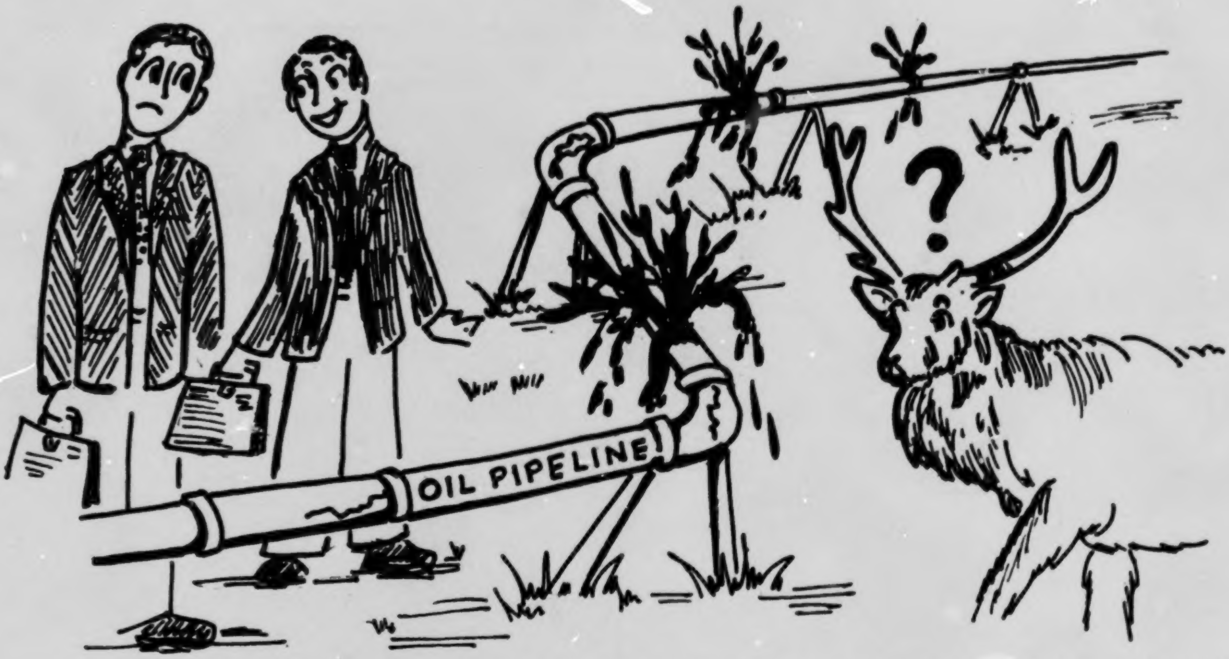
NATURAL GAS AND OIL PIPELINES IN ARKANSAS


0
25
MILES
Natural Gas
Oil Products
Compressor Station
Proposed Natural Gas

Source: Modified from ATLAS OF ARKANSAS

Student Worksheet

ARKANSAS OIL PIPELINES



"WELL, WE STILL HAVE TO WORK THE BUGS OUT."

1. What is the subject of this picture?
2. How is the pipeline supposed to deal with the problem of scarcity?
3. What tradeoffs were made in building the pipeline?
4. What is the cartoonist's attitude toward the pipeline? How do you know?
5. What questions should have been asked before building the pipeline?
6. Draw a cartoon of your own that reflects your attitude toward Arkansas oil production.

LESSON #8

CATEGORY: Uses

ENERGY TYPE: Petroleum

TITLE: Petroproducts in Arkansas

GRADE LEVEL: 7-10

INFUSE WITH SUBJECT AREA:
Social Studies

TIME NEEDED: One period

MATERIALS:
None

OBJECTIVES:

1. The students will recognize the amount of petroleum consumed by Arkansans per year.
2. The students will recognize the amount of petroleum consumed by both Americans and Arkansans per year as compared to other primary energy sources.
3. The students will recognize the uses Arkansans make of petroleum products.
4. The students will recognize the amount of gasoline usage in Arkansas per county.
5. The students will have an understanding of some products, other than gasoline, that are made from petroleum.

TASK ANALYSIS:

The students should be able to read and interpret graphs; and should have the vocabulary necessary to understand this lesson.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 8.5 - 8.10.
   Read Teacher Background Information (8.3 - 8.4).

2. Steps in Lesson
   Objective #1: The students will recognize the amount of petroleum consumed by Arkansans per year.

   a. Share in class discussion the material found on Teacher Background Information (8.3 - 8.4).
   b. Hand out and discuss Student Worksheet 8.5. Ask the students such questions as:
      -How has the total consumption of petroleum products in Arkansas changed since 1961? (Tripled, 24 million barrels to 70 million barrels).
      -How much did gasoline consumption grow? (Double).
      -How much did consumption of other petroleum products grow? (Quadrupled).

   Objective #2: The students will recognize the amount of petroleum consumed by both Americans and Arkansans per year as compared to other primary energy sources.

a. Hand out Student Worksheet 8.6. Have each student answer the questions about the graph, then discuss the answers as a group.

Objective #3: The students will recognize the uses Arkansans make of petroleum products.

a. Hand out Student Worksheet 8.7. Have each student answer the questions, then discuss the answers as a group.

Objective #4: The students will recognize the amount of gasoline usage in Arkansas per county.

a. Share in class discussion the material found on Teacher Background Information (8.3 - 8.4)
b. Hand out Student Worksheet 8.8. Refer back to Worksheet 8.5.
c. Answer the following questions as a group:
   -How much gasoline was consumed by Arkansans in 1979?
   (About 31 million barrels)
   -Which Arkansas county is the top gasoline consumer per year?
   (Pulaski)
   The least? (Newton)
   -The counties are divided into the top, mid and low "25" gasoline users; can you give some reasons that would account for such wide ranges of use?
   (Population, topography, city locations, tourism)
   -Find your county. How much gasoline did your county use in comparison to other Arkansas counties?

Objective #5: The students will have an understanding of some products, other than gasoline, that are made from petroleum.

a. Either:
   -Have students brainstorm petrochemical products used in everyday life and list them on the board.
   -Hand out Student Worksheet 8.9.
b. Have students mark each item on the list using the following key:
   Red - necessary for life.
   Yellow - necessary to maintain present lifestyle.
   Green - luxury
   Blue - could be made from renewable resource, rather than petroleum
   (Some items may have more than one color)
c. After color-coding the list of petrochemical products, answer the following questions in class discussion.
   -What is conservation?
   -What are some ways the people of Arkansas could conserve petroleum?
   -Would conservation of petroleum necessarily cause a reduction in our present lifestyle? Why or why not?

3. Evaluation

Test student understanding of energy vocabulary by having them write sentences using the words introduced in this lesson. Assign students to write a list of their activities for the day, so far. Have them underline each activity done, or product used, that depended on petroleum. Ask them to list renewable substances that can be used, in place of petroleum, without decline in their lifestyles.

4. Follow-Up-Activities

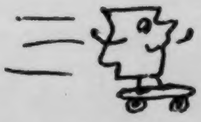
Student Worksheet 8.10.

TEACHER BACKGROUND INFORMATION

Source:

Arkansas Energy Office. Little Rock.

Petroleum fuels, because of Arkansas' heavy dependence on them, have been the most important source of energy consumed in the state. In 1978, petroleum products accounted for 54.9 percent of the state's primary fuel consumption. The transportation sector was the major consumer of petroleum products comprising 53.2 percent of the total. The remaining petroleum product consumption is accounted for by 21.5 percent in electric power generation, 13 percent used in the household-commercial sector, 10.8 percent in the industrial sector and 1.5 percent in miscellaneous uses.



After increasing at an average annual rate of 8.6 percent from 1963 through 1973, petroleum product consumption in Arkansas grew at a lower rate of 2.7 percent from 1973 through 1978. Petroleum consumption reached approximately 200,000 barrels per day in 1978, almost double the 1968 consumption level. As recently as 1963, Arkansas produced more petroleum than it consumed. In 1978, however, Arkansas imported 72 percent of its petroleum product needs.

The petroleum products consumed in Arkansas include gasoline, distillate (mainly diesel fuel), residual fuel oil, jet fuel, kerosene, liquid gas and asphalt. Of these, by far the most significant component of petroleum demand is gasoline, representing 41.5 percent of total petroleum consumed in 1978 and 78 percent of petroleum consumption in the transportation sector.

From 1973 to 1978, gasoline demand in Arkansas increased at an average annual rate of about 2.5 percent. In 1979, gasoline demand was down 6 percent from demand in 1978, the first drop in demand since 1974 after the OPEC Embargo. The other significant components of petroleum demand -- distillate, residual fuel and liquid gases -- accounted for 18.6 percent, 26.1 percent and 6.7 percent of demand respectively in 1978.

Petroleum production in Arkansas was 18,869,163 barrels, down 7.2 percent from production in 1978. In 1979, Arkansas' 201 oil fields had 8,115 producing wells at year end and enhanced recovery accounted for 44 percent of the total oil production. Arkansas' 1979 petroleum production had an estimated value of $273,602,864.

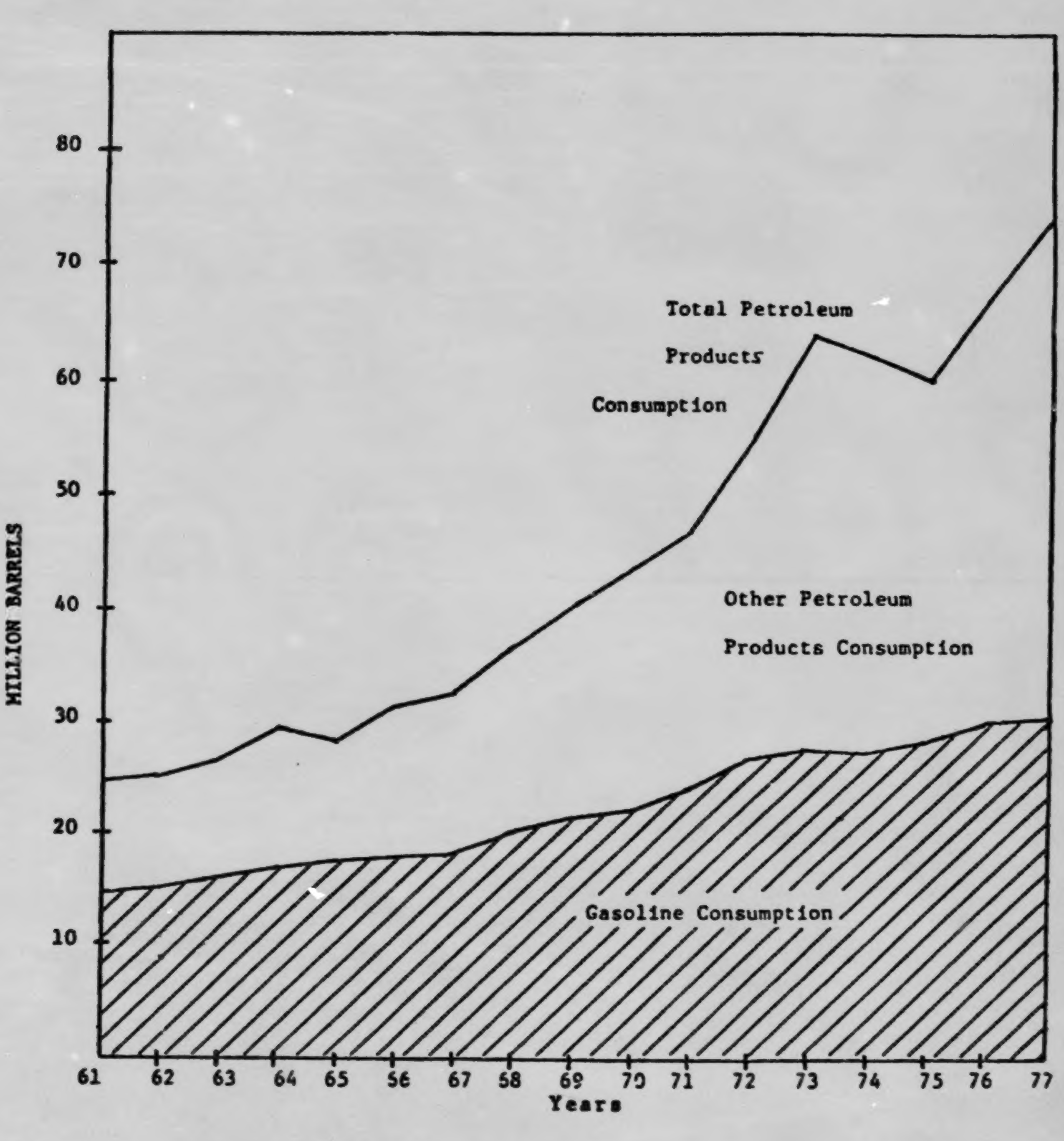
Petroleum reserves are estimated by the Arkansas Oil and Gas Commission to be 315 million barrel as of January, 1979. At present rates of production, and with no new discoveries, these reserves will last approximately 17 years. At Arkansas' present rate of consumption, 315 million barrels of oil would last only 4 years.

From 1960 to 1973 petroleum prices remained relatively stable. Starting in 1974, however, prices began to rise dramatically showing the largest increase in

1979. From 1974 to 1979, refiner acquisition costs of crude oil doubled going from $9.02 per barrel to $17.72 per barrel. Prices of specific petroleum products has shown equally dramatic increases. The average retail price of gasoline in Arkansas in 1974 was 50.66 cents per gallon and in 1979 it was 85.36 cents per gallon, representing an overall increase of 68.5 percent and an average annual increase of 10.4 percent. By comparison, the average annual increase in the price of food for the same period was 7.4 percent. At the end of 1979, gasoline prices were over a dollar a gallon. Other petroleum products showed similar price jumps. The average annual retail price of diesel fuel rose from 34.7 cents per gallon in 1976 to 62.4 cents per gallon in 1979, an increase of 80 percent. The retail price of residual fuel oil, used primarily in industry and electric power generation, rose 62 percent between 1976 and 1979.

Student Worksheet

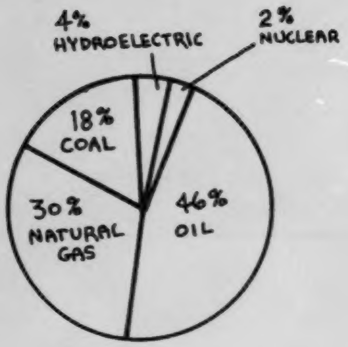
ARKANSAS PETROLEUM PRODUCT
CONSUMPTION BY YEAR



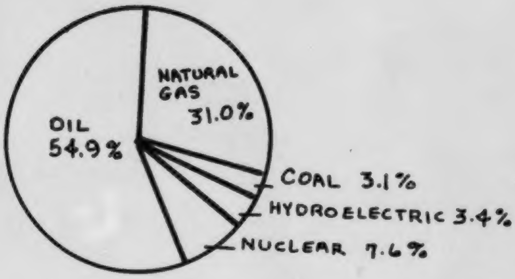
Source: United States Department of Energy; Arkansas Department of Finance and Administration

Student Worksheet

PRIMARY ENERGY SOURCES



Where United States Primary
Energy Comes From



Where Arkansas Primary
Energy Comes From

Source: Arkansas Energy Office

Using the graphs above, answer the following questions.

1. What Primary energy source do we use most?
   United States ______________________ Arkansas ______________________
2. Which do we use mostly for heating our homes?
   United States ______________________ Arkansas ______________________
3. What energy source provides most of the fuel for our transportation.
   United States ______________________ Arkansas ______________________
4. Which one makes most of our electricity?
   United States ______________________ Arkansas ______________________
5. Why in the past, have we used such a large proportion of fossil fuels in comparison to hydroelectric and nuclear?
   United States -
   Arkansas -
6. Why is electricity not shown on this chart?

Student Worksheet

PRIMARY ENERGY SOURCES

ANSWER SHEET

1. United States: Oil
   Arkansas: Oil

2. United States: Natural Gas
   Arkansas: Natural Gas

3. United States: Oil
   Arkansas: Oil

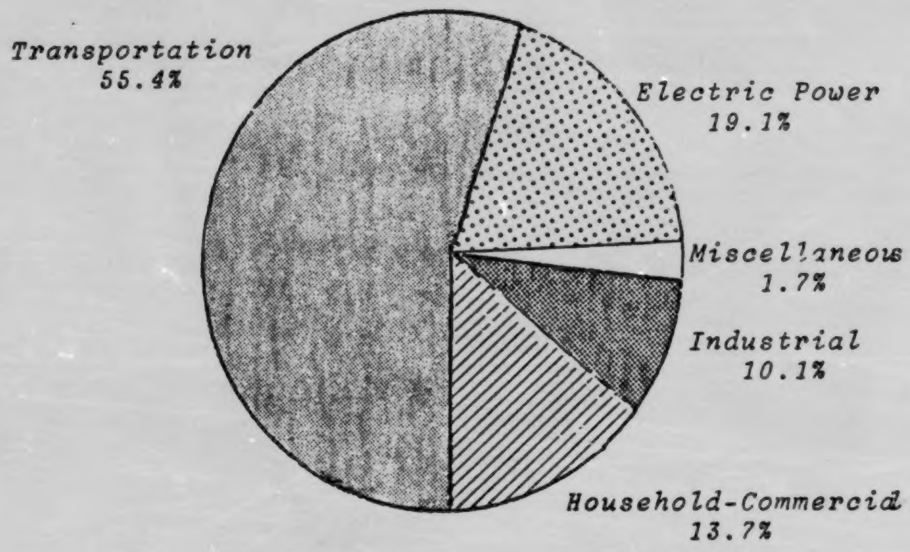
4. United States: Coal
   Arkansas: Oil

5. United States and Arkansas: low-cost foreign oil supplies.

6. It is a secondary, not primary, energy.

Student Worksheet

ARKANSAS CONSUMPTION OF PETROLEUM PRODUCTS BY USE



Total 72, 828 Thousand Barrels

Source: Arkansas Energy Office

Using the graph above, answer the following questions.

1. What sector uses the most petroleum?

2. What sector(s) do you and your family have the most impact on?

3. Give your ideas of what we should do in Arkansas to help the energy shortage situation.

127

Student Worksheet

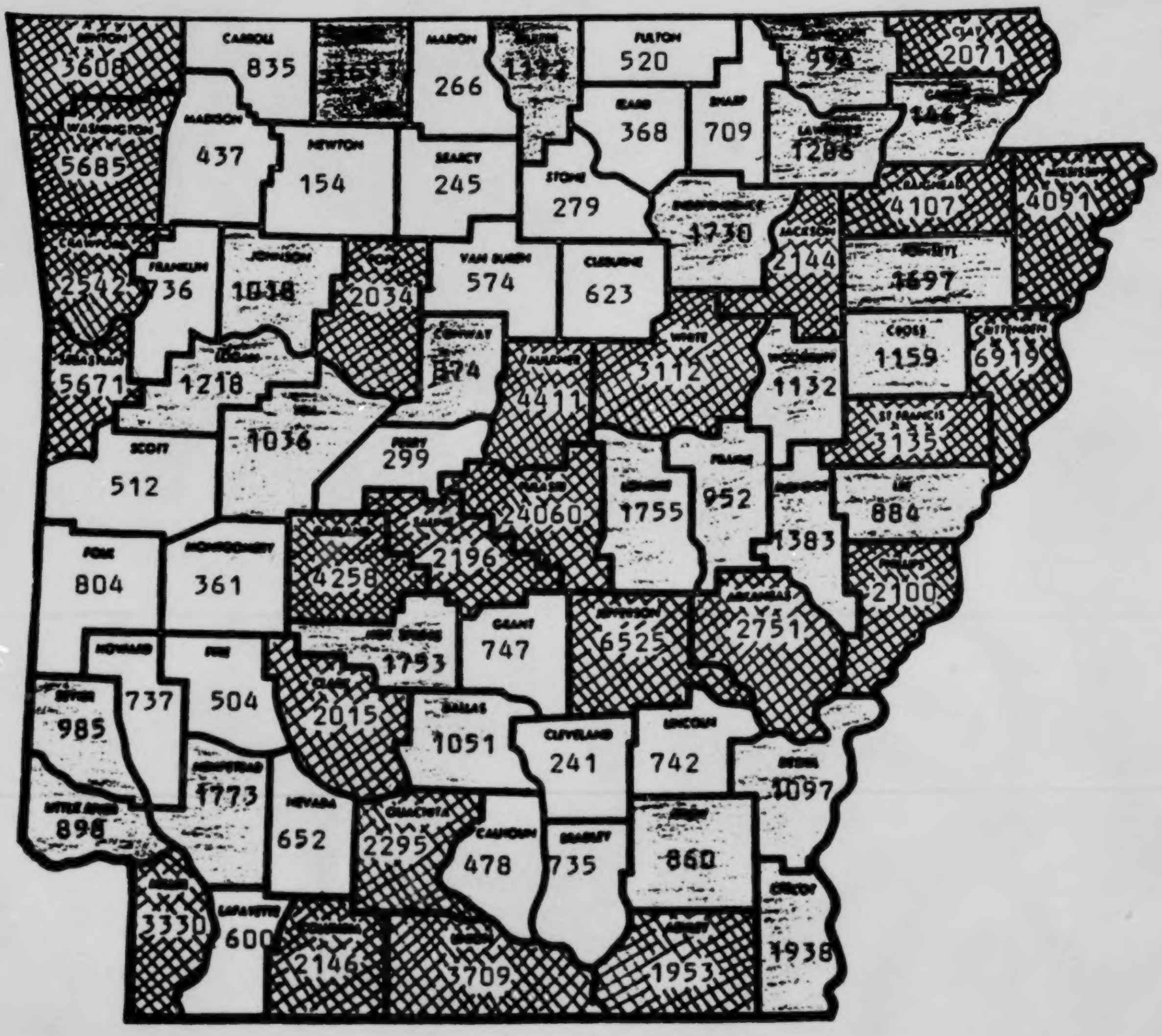
ARKANSAS CONSUMPTION OF PETROLEUM PRODUCTS BY USE

ANSWER SHEET

1. Transportation
2. Transportation; household
3. (Variable answers)

Student Worksheet

ARKANSAS GASOLINE USE


3608
835
266
520
994
2071
5685
437
154
245
368
709
1286
279
4107
4091
2542
736
1018
2034
574
623
1730
2144
1697
5671
1218
674
4411
3112
1132
1159
6919
1036
299
3135
512
24060
1755
952
1383
884
804
361
4258
2196
2100
747
6525
2751
1793
737
504
985
2015
1051
241
742
1773
1097
896
652
2295
478
735
860
3330
600
2146
3709
1953
1938

Data Source: Brookhaven National Laboratory 1976

ARKANSAS

GASOLINE USE
(In Billions of BTU)

GRAPHIC SCALE IN MILES

"Top 25": 1953-24060 ▩
"Mid 25": 860- 1938 ■
"Low 25": 1154- 835 ☐

Student Worksheet

WHAT CAN YOU MAKE FROM ENERGY?

Most people think of "energy" as gasoline for their cars or heat for their homes. But 4.5 percent of the nation's oil and natural gas is used by industries as a petrochemical raw material: every one of the products listed here and thousands more are made from petrochemicals.

- ☐ Credit cards
- ☐ American flags
- ☐ Eyelashes
- ☐ Aspirin
- ☐ No-wax floors
- ☐ Permanent-press clothes
- ☐ Oxygen masks
- ☐ Golf balls
- ☐ Ink
- ☐ Lighter fluid
- ☐ Heart valves
- ☐ Hair spray
- ☐ Attache cases
- ☐ Crayons
- ☐ Steering wheels
- ☐ Wet suits
- ☐ Disposable diapers
- ☐ Food wraps
- ☐ Laxatives
- ☐ Parachutes
- ☐ Stretch pants
- ☐ Trash cans
- ☐ Telephones
- ☐ Rubber duckies
- ☐ Brassieres
- ☐ Enamel
- ☐ Seed tape
- ☐ Wall coverings
- ☐ Transparent tape
- ☐ Card tables
- ☐ Acrylic paints
- ☐ Antiseptics
- ☐ Golf cart bodies
- ☐ Vacuum bottles
- ☐ Vinyl siding
- ☐ Slips
- ☐ Shoe trees
- ☐ Safety flares
- ☐ Warm-up suits
- ☐ Bearing grease
- ☐ Overcoats
- ☐ Ping-pong paddles
- ☐ Rafts
- ☐ Bubble bath
- ☐ Purses
- ☐ Sockets
- ☐ Bookends
- ☐ Weed killers
- ☐ Flippers
- ☐ Planters
- ☐ Football pads
- ☐ Tiles
- ☐ Deodorant
- ☐ Puzzles
- ☐ Air conditioners
- ☐ Panty hose
- ☐ Backpacks
- ☐ Upholstery
- ☐ Uniforms
- ☐ Phonographs
- ☐ Hearing aids
- ☐ Welcome mats
- ☐ Car sound insulation
- ☐ Racks
- ☐ Pacifiers
- ☐ Dresses
- ☐ Cassettes
- ☐ Garment bags
- ☐ Track shoes
- ☐ Dominoes
- ☐ Fences
- ☐ Car polishers
- ☐ Luggage
- ☐ Kitchen counter tops
- ☐ Protractors
- ☐ Antifreeze
- ☐ Earphones
- ☐ Flashlights
- ☐ Windbreakers
- ☐ Whistles
- ☐ Motorcycle helmets
- ☐ Pillows
- ☐ Clothesline
- ☐ Dune buggy bodies
- ☐ Carpet sweepers
- ☐ Antibiotics
- ☐ Checkers
- ☐ Chess boards
- ☐ Shower doors
- ☐ Soap dishes
- ☐ Yardsticks
- ☐ Shorts
- ☐ Syringes
- ☐ Slip covers
- ☐ Sugar bowls
- ☐ Shoes
- ☐ Paddles
- ☐ Decoys
- ☐ Volley balls
- ☐ Tobacco pouches
- ☐ Sleeping bags
- ☐ Refrigerator linings
- ☐ Pencils
- ☐ Electrician's tape
- ☐ Model cars
- ☐ Midi-skirts
- ☐ Kites
- ☐ Folding doors
- ☐ Mini-skirts
- ☐ Floor wax
- ☐ Garden hoses
- ☐ Mascara
- ☐ Paneling
- ☐ Lawn sprinklers
- ☐ Sports car bodies
- ☐ Stoppers
- ☐ Straps
- ☐ Smocks
- ☐ Tennis balls
- ☐ Tires
- ☐ Tablecloths
- ☐ Measuring cups
- ☐ Rulers
- ☐ Ring binders
- ☐ Reclining chairs
- ☐ Boat covers
- ☐ Tote bags
- ☐ Dishwashing liquids
- ☐ Unbreakable dishes
- ☐ Toothbrushes
- ☐ Extension cords
- ☐ First-aid kits
- ☐ Notebooks
- ☐ Combs
- ☐ Watchbands
- ☐ Darts
- ☐ Flight bags
- ☐ Toothpaste
- ☐ Flea collars
- ☐ Drip-dry dresses
- ☐ Tents
- ☐ Stadium cushions
- ☐ Plastic varnish
- ☐ Finger paints
- ☐ Foul weather gear
- ☐ Foot pads
- ☐ Refrigerants
- ☐ Rugs
- ☐ Nightgowns
- ☐ Sandals
- ☐ Hair curlers
- ☐ Lamps
- ☐ Lipstick
- ☐ Laminates
- ☐ Ice cube trays
- ☐ Typewriter cases
- ☐ Visors
- ☐ Swimming pool liners
- ☐ Laundry softeners
- ☐ Electric blankets
- ☐ Ear plugs
- ☐ Tennis rackets
- ☐ Shirts
- ☐ Drinking cups
- ☐ Canisters
- ☐ House paint
- ☐ Lamp shades
- ☐ Computer tape
- ☐ Cough syrup
- ☐ Rollerskate wheels
- ☐ Movie film
- ☐ Vinyl tops
- ☐ Digital clocks
- ☐ Draperies
- ☐ Ice chests
- ☐ Life jackets
- ☐ Audio tape
- ☐ TV cabinets
- ☐ Model planes
- ☐ Car battery cases
- ☐ Measuring tape
- ☐ Insect repellent
- ☐ Hockey pucks
- ☐ Ice buckets
- ☐ Fishing nets
- ☐ Fertilizers
- ☐ Hiking boots
- ☐ Hair coloring
- ☐ Knitting yarn
- ☐ Toilet seats
- ☐ Towel bars
- ☐ Denture adhesive
- ☐ Frisbees
- ☐ Hair rollers
- ☐ Light fixtures
- ☐ Loudspeakers
- ☐ Movie film
- ☐ Panties
- ☐ Electronic calculators
- ☐ Fishing boots
- ☐ Candles
- ☐ Diving masks
- ☐ Hairbrushes
- ☐ Body suits
- ☐ Water pipes
- ☐ Pails
- ☐ Car enamel
- ☐ Guitar picks
- ☐ Vinyl shingles
- ☐ Switch plates
- ☐ Shower curtains
- ☐ Sponges
- ☐ Detergents
- ☐ Beach balls
- ☐ Ties
- ☐ Sunglasses
- ☐ Bird houses
- ☐ Bathinettes
- ☐ Records
- ☐ Typewriter ribbons
- ☐ Footballs
- ☐ Disposable lighters
- ☐ Doorknobs
- ☐ Sewing machine cases
- ☐ Fishing reels
- ☐ Mattresses
- ☐ Lifeboats
- ☐ Girdles
- ☐ Plastic wood
- ☐ Stuffed animals
- ☐ Car mats
- ☐ Soft contact lenses
- ☐ Dog leashes
- ☐ Dice
- ☐ Trash bags
- ☐ Thermal blankets
- ☐ Drinking straws
- ☐ Afghans
- ☐ Pole vaulter poles
- ☐ Foam insulation
- ☐ Hand lotion
- ☐ Shampoo
- ☐ Shaving cream
- ☐ Aquariums
- ☐ Sails
- ☐ Soft bumpers
- ☐ Safety glass
- ☐ Erasers
- ☐ Radio cases
- ☐ Awnings
- ☐ Knitting needles
- ☐ Fan blades
- ☐ Wigs
- ☐ Window shutters
- ☐ Salad bowls
- ☐ Epoxy glue
- ☐ Punching bags
- ☐ Model ships
- ☐ Shavers
- ☐ Plywood adhesive
- ☐ Parkas
- ☐ Football suits
- ☐ Cameras
- ☐ Shoelaces
- ☐ Swizzle sticks
- ☐ Piano keys
- ☐ Bikinis
- ☐ Bracelets
- ☐ Football helmets
- ☐ Anesthetics
- ☐ Plungers
- ☐ Artificial turf
- ☐ Patio furniture
- ☐ Ashtrays
- ☐ Artificial limbs
- ☐ Rain hats
- ☐ Bandages
- ☐ Dentures
- ☐ Belts
- ☐ Tongs
- ☐ Tumblers
- ☐ Car seats
- ☐ Popcorn poppers
- ☐ Poker chips
- ☐ Mops
- ☐ Eye shadow
- ☐ "Tiffany" lamps
- ☐ Typewriter keys
- ☐ Wire insulation
- ☐ Desk organizers
- ☐ Fake furs
- ☐ T-shirts
- ☐ Electric scissors
- ☐ Golf bags
- ☐ Skin conditioners
- ☐ Photographs
- ☐ Outdoor carpeting
- ☐ Tool boxes
- ☐ Salt shakers
- ☐ Screen door screens
- ☐ Sculptures
- ☐ Caulking
- ☐ Fan belts
- ☐ Tape recorders
- ☐ Distributor housings
- ☐ Window shades
- ☐ Dog food dishes
- ☐ Curtains
- ☐ Dog toys
- ☐ Lids
- ☐ Pan handles
- ☐ Slippers
- ☐ Tennis shirts
- ☐ Tent pegs
- ☐ Tennis shorts
- ☐ Vitamin capsules
- ☐ Dashboards
- ☐ Ribbons
- ☐ Putty
- ☐ Percolators
- ☐ Swings
- ☐ Skis
- ☐ Tool racks
- ☐ Folding chairs
- ☐ Charcoal lighter
- ☐ Gas siphons
- ☐ Robes
- ☐ Picture frames
- ☐ Air mattresses
- ☐ Petticoats
- ☐ Seat covers
- ☐ Slacks
- ☐ Hampers
- ☐ Lighting panels
- ☐ Yarn
- ☐ Jars
- ☐ Spools
- ☐ Wastebaskets
- ☐ Wall plugs
- ☐ Insecticides
- ☐ Baby bottles
- ☐ Fishing lures

Source: Union Carbide. 1978.

Student Worksheet

PETROLEUM AND THE WAY YOU LIVE

Fill in the blanks in the following story from the list of words at the bottom of the page (all products made from petroleum). Each word will be used at least once. How many petroleum or petrochemical products can you think of that you used before school this morning?

Alex, an eighth grader at Razorback Junior High, hated to get up one dreary, rainy day. Alex flicked on the _________ lights and washed his hair with _________ shampoo. To cheer himself up, he put on his brightest plaid ____________ sweater. On the way downstairs, Alex passed his sister's room as she was fixing her new hairdo with her can of ________________ hairspray. Down in the kitchen, Alex's mother had fixed him some eggs in a ______-coated pan, using her ______________________ range. Alex's mother complained that he ate too quickly from the colorful ___________________ plate and insisted that, because it was raining, Alex wear his ________________________ boots. All that hassle had given him a headache, so he gulped down an _______, grabbed his peanut butter sandwich wrapped in ____________ and banged the __________ storm door on the way out. On the way to the corner, Alex slipped in a puddle on the _______ roadway. Finally, he climbed on the bus, powered by high octane ________. He sank bank onto the _____-covered seat and unrolled a butterscotch drop from a __________ wrapper, opened his ________________ notebook, and started his homework from the night before.

plexiglass
teflon
detergent
aerosol-propelled
asphalt

plastic wrap
gasoline
vinyl
acrylic knit
melamine plasticware
synthetic rubber

aspirin
electric
natural gas
synthetic leather
cellophane

Student Worksheet

PETROLEUM AND THE WAY YOU LIVE
ANSWER SHEET

Fill in the blanks in the following story from the list of words at the bottom of the page (all products made from petroleum). Each word will be used at least once. How many petroleum or petrochemical products can you think of that you used before school this morning?

Alex, an eighth grader at Razorback Junior High, hated to get up one dreary, rainy day. Alex flicked on the electric lights and washed his hair with detergent shampoo. To cheer himself up, he put on his brightest plaid acrylic knit sweater. On the way downstairs, Alex passed his sister's room as she was fixing her new hairdo with her can of aerosol-propelled hairspray. Down in the kitchen, Alex's mother had fixed him some eggs in a teflon-coated pan, using her electric or natural gas range. Alex's mother complained that he ate too quickly from the colorful melamine plasticware plate and insisted that, because it was raining, Alex wear his synthetic rubber or vinyl boots. All that hassle had given him a headache, so he gulped down an aspirin, grabbed his peanut butter sandwich wrapped in plastic wrap and banged the plexiglass storm door on the way out. On the way to the corner, Alex slipped in a puddle on the asphalt roadway. Finally, he climbed on the bus, powered by high octane gasoline. He sank back onto the vinyl-covered seat and unrolled a butterscotch drop from a cellophane wrapper, opened his synthetic leather notebook, and started his homework from the night before.

plexiglass
teflon
detergent
aerosol-propelled
asphalt
plastic wrap
gasoline
vinyl
acrylic knit
melamine plasticware
synthetic rubber
aspirin
electric
natural gas
synthetic leather
cellophane

LESSON #9

CATEGORY: Sources	**ENERGY TYPE:** Petroleum
TITLE: International Oil	**GRADE LEVEL:** 9-12
INFUSE WITH SUBJECT AREA:	**TIME NEEDED:** One period

MATERIALS:

Several world maps

OBJECTIVES:

1. The students will analyze world energy consumption.
2. The students will become familiar with the nations throughout the world which have sources of oil.
3. The students will analyze some facts of how the energy crisis affects developing nations.

TASK ANALYSIS:

The students should be familiar with such terms as OPEC, developing nations, GNP, exports, imports; be able to find nations and continents on a world map; and be able to read and interpret a bar graph.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 9.4 - 9.11.
   Place world map in view of the class.

2. Steps in Lesson
   Objective #1: The students will analyze world energy consumption.

   a. Hand out Student Worksheets 9.4 - 9.5. Ask the students to study the graph and answer the questions. Discuss the answers as a group.
   b. Hypothesize reasons why consumption has risen; why the United States uses so much more than the other nations; why the projections show the United States percent for the year 2000 as less than some (developing) communist nations.

   Objective #2: The students will become familiar with the nations throughout the world which have sources of oil.
   a. Hand out Student Worksheets 9.6 - 9.7. Discuss the Worksheets, then have students answer the questions independently. Check answers orally, then discuss proposed solutions.
   b. Hand out Student Worksheets 9.8 - 9.9. Discuss the material found on the chart. Have the students answer the questions independently or use the questions to trigger oral discussion of the table data.

Objective #3: The students will analyze some facts of how the energy crisis affects developing nations.

a. Hand out Student Worksheets 9.10 - 9.11. Have the students read the information, then answer the questions independently. Discuss the answers as a group.

3. Evaluation

Check answers to worksheet questions.
Use the following simulation game as an indication of student interest and understanding:
"Up for Graps"
Describe the following situation to the students: The Secretary General of the United Nations is just calling to order a special meeting. The purpose of this meeting is to divide up the world's oil in an equable fashion. A committee of impartial nations has been chosen to make this decision. This committee will listen to proposals by nations and various special interest groups as to the oil allocation. They will weigh all of these proposals, then make their decision.

Using the lesson just completed as background material, let the students list, then decide, what nations and groups should speak at the meeting. Some examples might be representatives of:
United States
OPEC (Organization of Petroleum Exporting Countries)
Canada
Third world nations
Communist nations
Japan
Western Europe
Mexico
An international environmental organization
An organization of oil companies
"Traditionally neutral" nations such as Switzerland, Sweden, Spain, Burma.

A decision should be made as to the amount of time given each group for its speech and following questions (possibly 5-10 minutes, depending on the number of speakers and class time).

Let the students volunteer for the part they would like to play: Secretary General, United Nations Committee, nation or organization representative. Give them sufficient time to research and prepare their argument (20-30 minutes), then have the Secretary General call the meeting to order.

After the simulation is completed, questions/topics such as the following might be discussed:
-What were the purposes of the speakers in the hearing?
-How did you feel about the impartiality of the committee of nations?

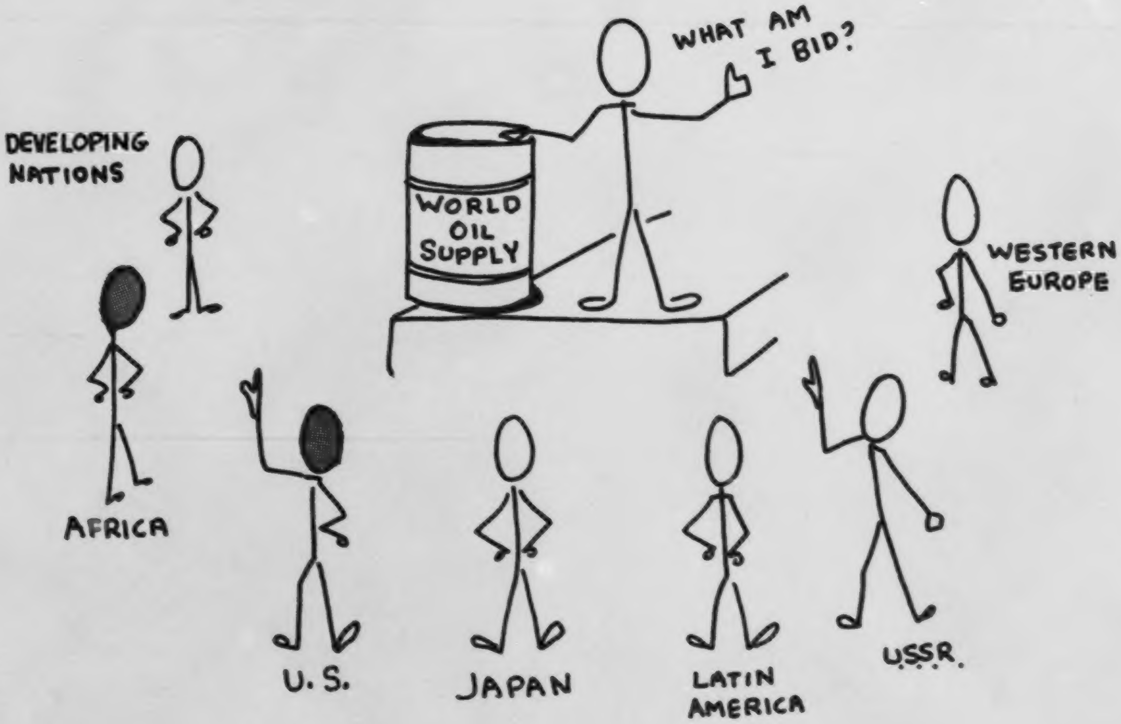
-Do you feel it is possible to be truly impartial in a situation such as an oil crisis?
Why or why not?

-What do you think of having committee meetings, such as this one, televised and open to the public?
What bearing might openness have on the comments of the speakers and the decisions of the committee?

-Hypothesize other methods (other than by hearings and committee choices) of making decisions, such as oil allocation.

4. Follow-Up Activities

Less on "Petrodollars" designed by the United States Department of Energy, available free; request "Energy in The Global Marketplace" #3841-0007, from the United States Department of Energy, Technical Information Center, Box 62, Oak Ridge, Tennessee 37830. This lesson contains a simulation game that expresses demand and supply concepts in oil buying.

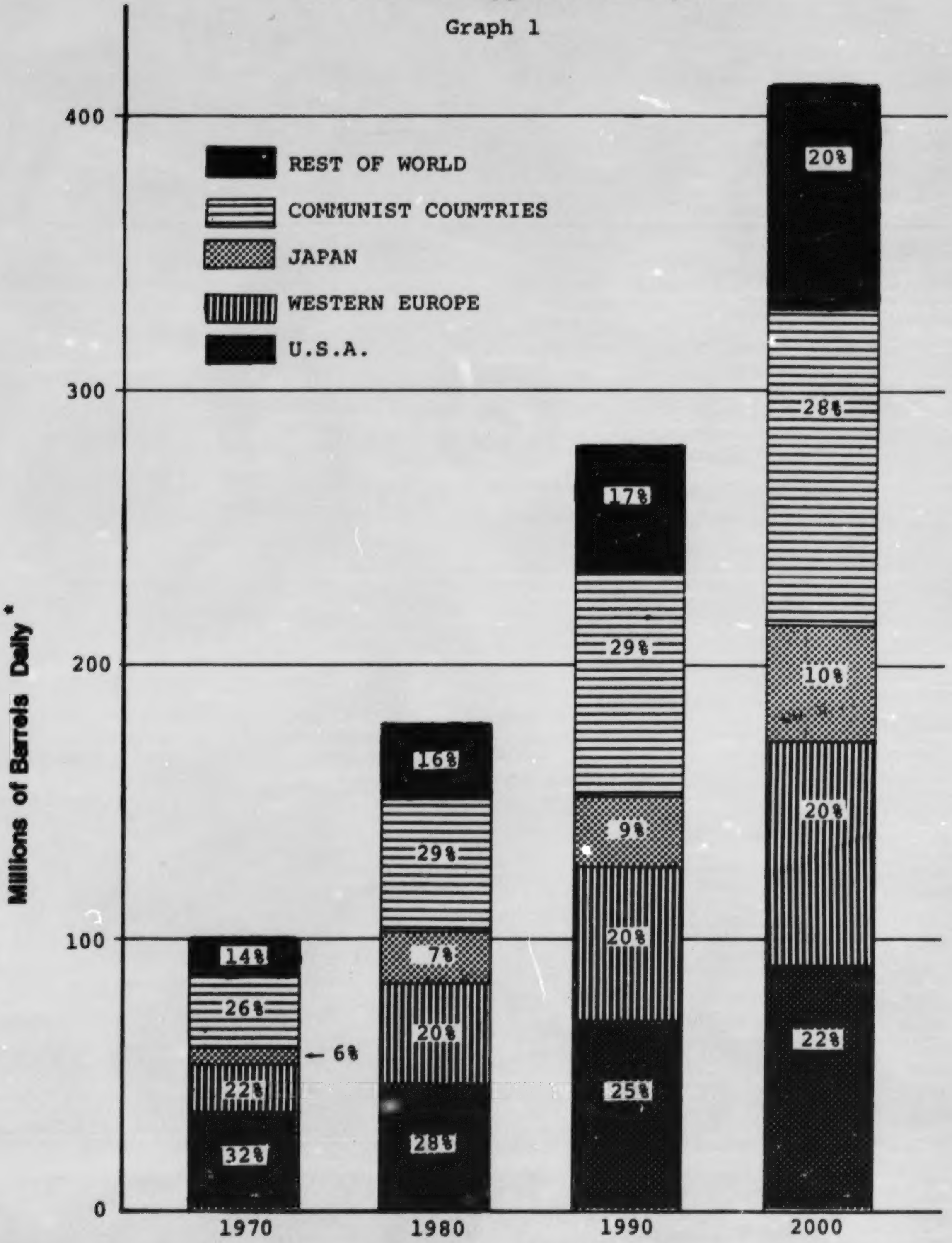

WHAT AM I BID?
WORLD OIL SUPPLY
DEVELOPING NATIONS
WESTERN EUROPE
AFRICA
U.S.
JAPAN
LATIN AMERICA
USSR.

Student Worksheet

WORLD ENERGY CONSUMPTION

World Energy Consumption

Graph 1



Source: United States Department of Energy

*All sources of energy expressed as equivalent to crude oil.

Student Worksheet

WHAT IF . . . .
EVERYBODY WANTS MORE?

Answer the following questions using the graph on Worksheet 9.4:

1. What was the daily world energy consumption in 1970?

2. What is the predicted daily consumption by 2000?

3. In 1970 what percent of the total world's daily consumption did the United States use?

4. What trend is predicted for the United States in its use of the world's energy supplies? A smaller or larger percentage?

5. There is a limited amount of oil in the ground. What conflicts can you see developing in international relations over this fact? Base your answer on the trends you see in the graph.

6. In the year 2000 which nation(s) is predicted to be using the most energy?

7. Do you agree with the predictions made by this chart?
Why or why not?

Student Worksheet

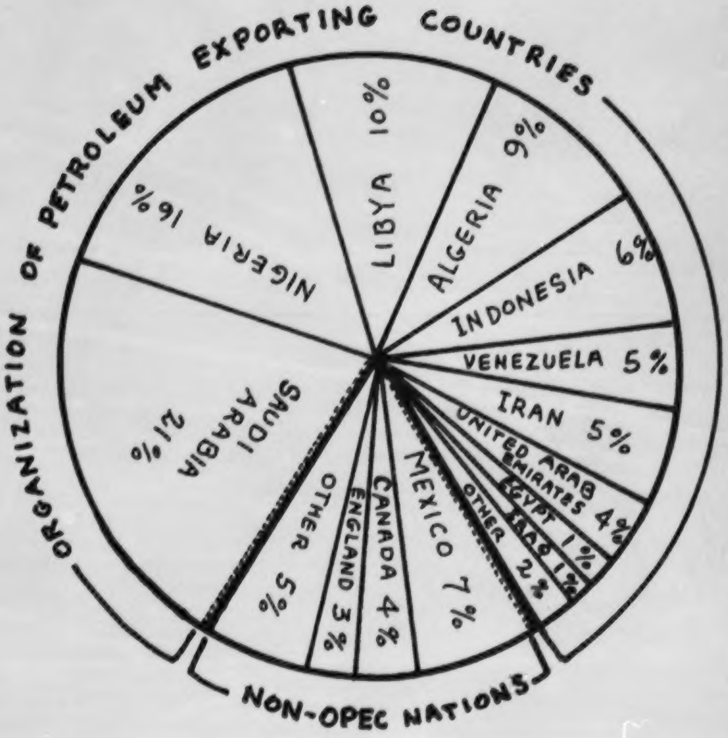
WHAT IF . . . .
EVERYBODY WANTS MORE?

ANSWER SHEET

1. The equivalent of 100 million barrels of crude oil per day.
2. Over 400 million barrels of oil per day.
3. 32 percent.
4. Smaller.
5. Communist nations and the rest of the world (developing nations) will be demanding a larger share.
6. Communist nations
7. Answers vary.

Student Worksheet

THE OIL WE IMPORT



PERCENT OF TOTAL U.S. CRUDE IMPORTS IN 1978

Because the United States has a demand for oil that is greater than its supply, it must buy oil from other nations to help meet the demand. This is called importing. During the last few years the imports of the United States have doubled, and the cost per barrel of oil has increased more than four times.

1. Find each nation shown on the graph on a world map. List each nation in its proper region below. Beside each nation's name write the percentage of oil the United States imports for it.

Europe

________________________ ____

North America

________________________ ____

________________________ ____

Latin America

________________________ ____

The Mideast

________________________ ____

________________________ ____

________________________ ____

________________________ ____

Africa

________________________ ____

________________________ ____

________________________ ____

________________________ ____

Southeast Asia

________________________ ____

2. What do the letters OPEC stand for?

3. Why are the OPEC nations important to the United States?

4. Which OPEC nation sells the United States the most crude oil? Which non-OPEC nation?

Student Worksheet

THE OIL WE IMPORT

5. Why does the United States need to import oil?

Check which of these solutions to the energy consumption problem seems workable to you.

_____Increase domestic production of fossil fuels.

_____Decrease our demand for oil.

_____Develop new energy alternatives.

_____Increase oil imports to fill growing demand.

_____Stop importing; become energy independent.

List methods by which the solutions you check above may be accomplished.

List any other solutions to the energy comsumption problem that you can think of.

Student Worksheet

THE OIL WE IMPORT

ANSWER SHEET

1. Europe:
   England - 3%

   North America:
   Mexico - 7%
   Canada - 4%

   Latin America:
   Venezuela - 5%

   The Mid East:
   United Arab Emirates - 4%
   Iran - 5%
   Iraq - 1%
   Saudi Arabia - 21%

   Africa:
   Algeria - 9%
   Egypt - 1%
   Libya - 10%
   Nigeria - 16%

   Southeast Asia:
   Indonesia - 6%

2. Organization of Petroleum Exporting Countries.

3. The OPEC nations have formed an association to regulate the price they charge for their crude oil; the United States imports part of its oil from the OPEC nations.

4. Saudi Arabia
   Mexico

5. The demand in the United States is greater than its supply of domestically produced oil.

Student Worksheet

UNITED STATES IMPORTS OF CRUDE OIL
BY COUNTRY OF ORIGIN
(Thousands of Barrels)

Area and Country	1975	1976	1977	1978	1979P
Bolivia	1,940	1,849	1,271	308	328
Canada	219,175	135,690	101,778	90,490	97,526
Colombia	---	2,041	---	---	---
Ecuador	20,679	18,671	20,229	13,910	11,363
Mexico	25,660	31,670	64,711	115,426	157,795
Trinidad	42,097	38,142	48,841	51,974	43,861
Venezuela	144,221	88,139	91,331	66,125	106,554
Total Western Hemisphere	453,772	316,202	328,468[1]	345,624[1]	432,173[1]
England	125	4,923	35,583	61,555	71,923
Netherlands	1,500	---	1,509	846	2,364
Norway	4,552	12,881	17,628	37,815	27,523
Total Europe	6,177	17,804	54,720	100,216	101,810
Algeria	96,459	149,190	198,468	231,253	220,074
Angola	26,051	2,426	6,150	2,290	14,088
Congo	---	3,142	2,440	5,454	909
Egypt	1,687	6,311	13,034	7,395	20,205
Gabon	9,811	9,685	12,632	13,841	15,328
Libya	81,403	162,457	256,984	232,897	232,704
Nigeria	272,265	370,962	412,498	332,035	389,115
Tunisia	839	5,400	10,425	4,460	6,429
Zaire	---	7,088	---	263	1,379
Total Africa	488,515	716,661	912,631	830,773[2]	906,206[2]
United Arab Emirates	42,585	93,105	121,640	140,653	102,108
Iran	101,575	109,073	193,415	202,357	107,811
Iraq	707	9,542	26,894	22,673	32,052
Israel	---	2,368	---	---	---
Kuwait	1,444	451	15,434	1,718	1,514
Oman	492	10,943	27,140	22,240	13,466
Qatar	6,657	8,631	24,281	23,224	11,450
Saudi Arabia	256,036	447,071	501,072	416,910	488,278
Total Middle East	409,496	681,184	910,744[3]	832,305[3]	759,944[3]
Indonesia	138,270	196,599	184,984	194,620	137,362
Malaysia	1,951	5,914	20,257	13,677	18,786
Total Far East	140,221	202,513	207,098[4]	210,632[4]	158,599[4]
U.S.S.R.	---	648	675	276	---
Total Eastern Hemisphere	1,044,049	1,618,810	2,085,859	1,974,202	1,932,326
ANNUAL TOTAL	1,498,181	1,935,012	2,414,327	2,319,826	2,364,499
% Western Hemisphere	30.3	16.3	13.6	14.9	18.3
% Eastern Hemisphere	69.7	83.7	86.4	85.1	81.7

[P] Preliminary

[2] Total Western Hemisphere includes 307 barrels from Chile in 1977, and 584 in 1978. Also 6,807 barrels from Peru in 1978 and 14,746 in 1979.

[3] Total Africa includes 885 barrels from Cameroon in 1978 and 5,771 in 1979. Also 204 from Ghana in 1979.

[4] Total Middle East includes 868 barrels in 1977, 2,530 in 1978 and 3,265 in 1979 from Syria.

[5] Total Far East includes 1,848 barrels in 1977, 2335 in 1978 and 2,451 in 1979 from Brunei.

Source: Energy information Administration, Annual Petroleum Statements, 1979 December Petroleum Statement. July 1980. 142

Student Worksheet

UNITED STATES TOTAL CRUDE OIL SUPPLY

	1975	1977	1979
Total Imports	37.0%	47.6%	53.7%
Total Domestic Supply	63.0%	52.4%	46.3%

Source: United States Department of Energy

Student Worksheet

UNITED STATES IMPORTS OF CRUDE OIL

Answer the following questions about the charts on Worksheet 9.8:

1. What percentage of the oil used in the United States daily was imported in 1975? What percentage was imported in 1979?
2. Where did the United States get most of its imported oil in 1975? In 1979?
3. Since the early 1970's presidents of the United States have urged residents to become less dependent on foreign oil. According to the table, have they been successful?
4. The United States has several potential sources of oil that are not in use today. Why does the United States continue to import oil rather than develop its domestic supply?
5. Why do you think some people are concerned about the trend in oil imports from the Middle East?
6. Is the United States importing more or less oil from OPEC nations?
7. How do the 1979 United States oil imports compare with the 1975 imports?
   How does the 1979 United States domestic oil production compare with the 1975 production?
   What trend does this indicate to you?

Student Worksheet

UNITED STATES IMPORTS OF CRUDE OIL

ANSWER SHEET

1. 37.0%
   53.7%

2. Nigeria
   Saudi Arabia

3. No

4. It has been cheaper to import oil than to develop domestic supplies.

5. The United States imported a large portion of oil from the Middle East in 1979. The Middle East is a politically unstable region and cutoffs of oil exports is a continuing possibility.

6. More in 1979 than in 1975.

7. Up 16.7%
   Down 16.7%
   The United States is still relying more on imported oil than on domestic oil.

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Student Worksheet

THE ENERGY CRISIS AND DEVELOPING NATIONS

In many ways the energy crisis has hit developing nations much harder than the industrial giants such as the United States and nations of Western Europe. The traditional energy sources of most developing nations (wood for heating and cooking and open grassland for animals) are becoming scarce; with increased scarcity comes increased cost.

Trees are a renewable resource, but they can only grow so fast. Because human populations are steadily increasing, more trees must be cut down to provide fuel. Younger trees with lower energy yields are now being utilized. When people are cold and hungry, they do not think of protecting young trees.

Without tree cover from weather, the topsoil (containing most of the soil's nutrients) begins to wash away. New trees cannot easily root without these nutrients. Rain will not soak into the subsoil quickly enough to renew the watertable; instead most of the rainwater runs off into gullies and is lost. Consequently, water wells must be drilled deeper and water pumped farther. These wells and pumps are high energy users and so the energy shortage gets even worse.

Until the 1973-4 oil embargo, many of the developing nations were starting to use more oil; then these nations found that their oil dependence made then vulnerable in their need for oil to run machinery pump wells and irrigate fields. The shortage of fuel for irrigation pumps in 1974 reduced the wheat harvest in India by an estimated one million tons.

The cost of oil has risen everywhere, but for many of the developing nations that do not have oil, the increase represents a large portion of their GNP (Gross National Product). As oil prices increase, so does the price of manufactured goods imported by these nations. The industrial nations must charge more for manufactured goods to cover the increased cost of oil; however, the price of the developing nations' exports is not rising fast enough to balance out the higher price of the imported goods. Developing nations are paying more for imported goods and getting less for exports. This imbalance is growing increasingly acute.

Some developing nations, such as West Africa's Nigeria and South Armerica's Venezuela, do produce oil and can use the profits from its sale to improve their living conditions. These nations are also trying to develop other resources, so that when the oil runs out they will not be left with only the memory of their wealth.

Some authorities believe that the non-oil-producing developing nations may contain half of the world's remaining undiscovered oil. If oil is found, it will mean some serious and difficult choices for the developing nations. For many, it might be more profitable to sell the oil at the present (1979) price of about $25 per barrel rather than using it in their own nation. The income from the sale of oil could then be used to develop renewable energy sources, such as solar power, which will last long after the oil supply has dried up.

In the meantime, the developing nations will continue to have a difficult time dealing with rising energy costs at home and around the world.

Source: World Watch Institute

Student Worksheet

THE ENERGY CRISIS AND DEVELOPING NATIONS

Answer the following questions about the material on Worksheet 9.10:

1. What have been traditional sources of energy in developing nations?
2. Why are these traditional sources unable to meet the needs of the people?
3. How does erosion create a need for more energy?
4. What is the relation between energy shortage and reduction in farm products?
5. List two ways developing nations have been harmed by the high oil prices.

Student Worksheet

THE ENERGY CRISIS AND DEVELOPING NATIONS

ANSWER SHEET

1. Wood and open grassland.
2. Population growing faster than the trees can renew themselves; open grassland being taken up for living space.
3. Rain will not soak into the subsoil and renew the watertable; as the watertable drops, wells must be dug deeper and water pumped farther. The wells and pumps are high energy users.
4. There is a need for fuel for running machinery, pumping wells and irrigating fields. If the farmer cannot afford the increased fuel prices, then he cannot produce as much.
5. Increased fuel prices and increased cost of imported manufactured goods.

LESSON #10

CATEGORY: Limits

ENERGY TYPE: Fossil Fuels

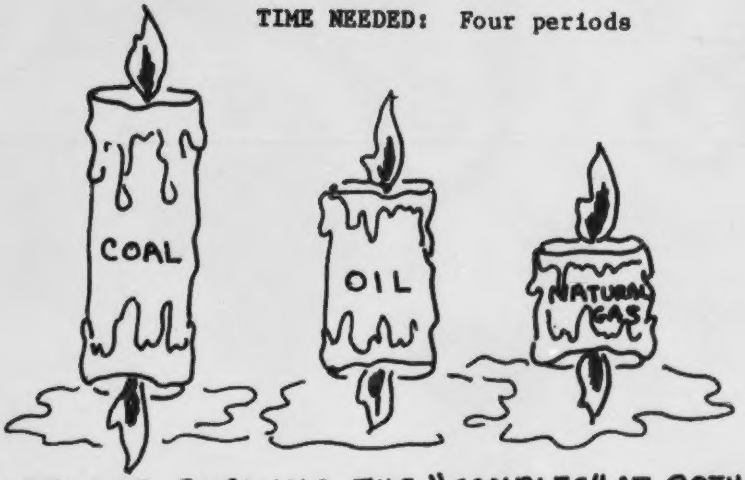
TITLE: Fossil Fuels: How Long Will They Last?

GRADE LEVEL: 8-10

INFUSE WITH SUBJECT AREA:
- Science
- Math
- Reading
- Social Studies

TIME NEEDED: Four periods

MATERIALS:
- Glass jar
- Small candles
- Ball of string
- Bag of red beans
- Butcher paper
- Markers or colors
- 1-pound bag of rice
- Chess board



ARE WE BURNING THE "CANDLES" AT BOTH ENDS?

OBJECTIVES:

1. The students will compare sources of fuel for the United States in 1979 and 1850.
2. The students will gain an understanding of the finite nature of fossil fuels.
3. The students will determine how long the oil and natural gas resources of Arkansas and the United States might last.
4. The students will recognize the time limits of today's fuel situation.
5. The students will recognize some advantages and disadvantages of coal as a fuel for the future.
6. The students will discover the relationship between energy supply and numbers of people.
7. The students will realize some of the problems that have been created by our dependence on fossil fuels.

TASK ANALYSIS:

The students should be able to do basic math computations; and be able to use reference materials.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 10.6 - 10.13.
   Gather above-listed materials.

2. Steps in Lesson
   Objective #1: The students will compare sources of fuel for the United States in 1979 and 1850.

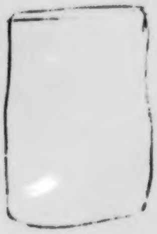
   a. Hand out Student Worksheet 10.6. Have the students answer the questions independently, then discuss the answers as a group.

Objective #2: The students will gain an understanding of the finite nature of fossil fuels.

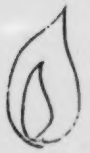
a. Using encyclopedia and other reference books, earth science and geology books, information from local utilities and industries, have the students research the time involved and the processes in progression from the formation of fossil fuels to the consumer. The students may work in groups on the following topics:
  - How did the fossil fuels get into the ground? How were they formed? What period of time was necessary for their formation? In what period of time in the history of the earth did this formation occur? In what areas of the earth were the fossil fuels formed? Are fossil fuels being formed today?
  - When and how were each of the fossil fuels first discovered? How were they obtained from the earth when they were first discovered? How were they used when they were first discovered?
  - Have groups of students research the methods by which coal, oil and natural gas are obtained from the earth. What period of time is required from the time of discovery of fossil fuels to when they can be brought to the surface?
  - How are the fossil fuels refined and transported to the consumer? What types of transportation are used? What types of transportation are used? What types of energy are consumed in this refining and transportation? How much energy is consumed in the refining and transportation processes?
  - Groups of students may be assigned to report on how these fuels, particularly oil and natural gas, are converted to heat within the home.

b. Students may make a time line showing the relative amounts of time from original formation to consumption. Murals or diagrams could be made to describe the entire process from formation to consumption.

COAL



OIL



Natural Gas

Objective #3: The students will determine how long the oil and natural gas resources of Arkansas and the United States might last.

a. Hand out Student Worksheets 10.7 - 10.8. Discuss how to complete the sheets. Have the students work independently or in groups to answer the questions. Discuss the answers as a group.

Objective #4: The students will recognize the time limits of today's fuel situation.

a. Hand out Student Worksheet 10.9. Answer the questions and discuss the Worksheet as a group.

Objective #5: The students will recognize some advantages and disadvantages of coal as a fuel for the future.

a. Tell the students that: At one time our nation ran on coal and wood. Then these sources were replaced by the cleaner burning and much cheaper oil as the principal source of energy. Now, it appears that, as oil becomes scarce, we may once again become a nation driven by coal and/or wood.

b. Ask the questions: Do you think this is true? Why or why not?

c. List the advantages of coal in terms of:
   -Abundance (we may have enough for centuries).
   -Accessibility (we know where it is and how to get it; no costly exploration is needed.
   -Cost (half the price of oil per unit of energy). Calculate the amount of coal it would take to supply your energy needs and the energy needs of your school. (One pound of coal is equal to one kilowatt of electric power).
   -Uses (a very versatile fuel that, with appropriate technology, can be converted to oil or gas).

d. Investigate the disadvantages of use of coal as a fuel.
   -High sulfur content means air pollution
   -Acid rains
   -Mining hazards
   -Acid wastes
   -Difficulty of reclamation of strip-mined lands

e. Describe your life if all the negative environmental effects of using coal are eliminated. (Plenty of energy, but very expensive).

f. Discuss industry and governmental recommendations that environmental restrictions on mining and burning coal be removed to increase production, at least until technology can be developed to remove sulfur and eliminate acid wastes. This discussion may be held in the following manner:
   -A research committee to do research on and present the causes and effects of acid rain.
   -A group in favor of lifting environmental restrictions on coal production and use.
   -A group against lifting these restrictions.

   Have the research committee present their findings, objectively, to the class. Then let each of the other partisan groups give their arguments for or against lifting the restrictions. The class should then vote on whose recommendations to follow.

Objective #6: The students will discover the relationship between energy supply and numbers of people.

a. Do one of the following energy activities. After playing either game, discuss the following:
   -Who gets the energy?
   -Compare the game with the world situation.
   -Did people get anxious, greedy or selfish?
   -Did people reach over borders?
   -Did people share?
   -How do you account for these behaviors?

"Inheritance"
Divide the class into three groups: group one-small, group two-larger, group three-largest. Instruct the groups that there will be no talking while the experiment is going on. Take a clear glass jar filled with small candies and place it in the center of group one. Explain to them that they have sixty seconds to do what they wish with the candy. After sixty seconds repeat the exercise with group two, after another sixty seconds repeat the exercise with group three. Now explain to the students the symbolism involved in this activity. Group one represented earth's past generations, group two represented earth's present generation and group three represented earth's future generations. The candy represented earth's finite resources, such as coal, oil and natural gas.

"Energy Beans"
Take the class outside. With a ball of string, lay out a circle about twenty feet in diameter. Use more string to divide the circle into eight smaller sections of different sizes. The circle now represents the earth divided into several nations of different sizes. Place half of the students in the nations to represent the populations. Be sure to have at least one small nation with three people and one large nation with only one person. Let the rest of the class stand around the circle. Show the class a bag of dried beans, preferable small and dark so they are harder to see. Say: These beans represent all the fossil fuel in the world. Scatter the beans (energy modules) unevenly around the "earth." Be sure to put only a few beans in the smallest nation and many beans in the largest. Ask each person to pick up on energy module. Two if you want the game to go faster. Have the students pick up one more energy module. Add one person to each nation to represent an increase in population. Have each person pick up another energy module. Continue the search for energy modules, with an occasional addition to the population, until the whole class is in the circle. When a population in a nation cannot find any more energy modules, it must leave the circle. Continue the game until only a few nations have energy modules left.

b. Do one of the following exercies:
"Population I"
Have the students experience population growth by creating a small enclosed space and doubling the number of students (1,2,4,8,16,32, etc.) placed into the space every four seconds.

"Population II"
Tell the students that the world is experiencing exponential growth in population and in energy use. It took until this century for the earth's population to reach 1 billion; it is now 4 billion and expected to double by the year 2000.

populations of some small nations should grow exponentially or double every time. Ask the students if they think a one pound bag of rice would be enought to cover a chess board if you put one grain in the first square, two grains in the next square, then 4, 8, 16, 32, etc. and kept doubling the number until the 64th square. By the time you reach square 14 over 10,000 grains will have been used; at square 21 over a million; at square 30 nearly 1-1/2 billion; and at square 64 approximately 1.3 sextillion grains of rice will have been used. Have the students count the grains of rice in a pound, find out the tons of rice produced in Arkansas per year and figure out how many years of production it would take to cover the chess board.

c. Discuss the effects of increasing world population and increasing demand for limited energy supplies, considering:
   -Economic effects.
   -Political effects.
   -Effects on the standard of living.
   -Effects on relationships among peoples.

Objective #7: The students will realize some of the problems that have been created by our dependence on fossil fuels.

a. Hand out Student Worksheet 10.10. Have the students answer the questions; then each student should use the form to interview an adult in the community. Have each student make up one question of his/her own under each heading. Compare the results of the interviews in class discussion.

3. Evaluation

Check answers on Student Worksheets for understanding of facts and accuracy of math.

4. Follow-Up Activities

Have students draw pictures of their homes and school in the "second coal age."

Have students investigate the productivity of a coal miner. (Ten to fifteen tons per day, but dropping in recent years).

Have students find out how coal is used in Arkansas and how it is transported.

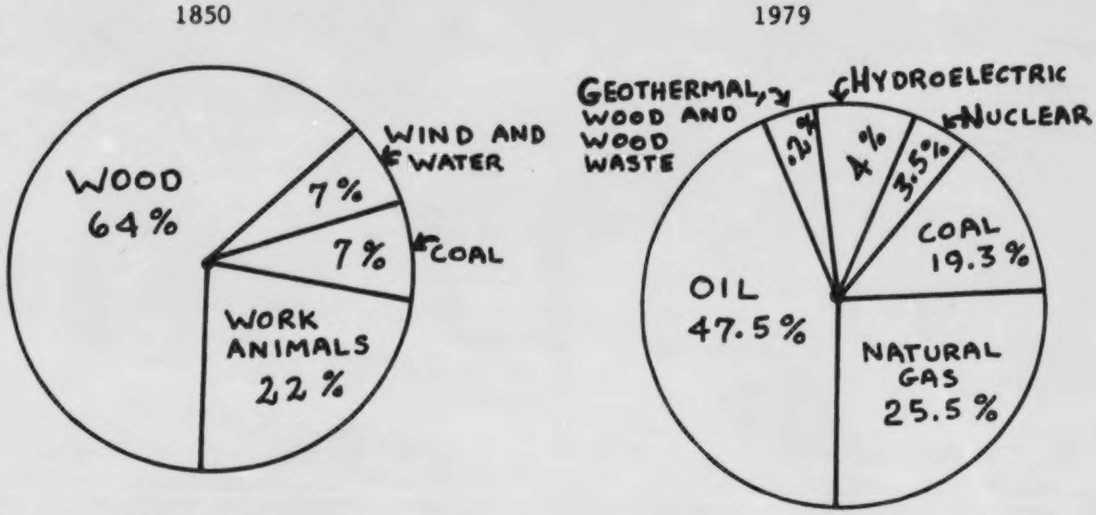
Order the four-unit packet Your Energy World from the United States Department of Energy, Conservation and Solar Applications, Washington, D.C. 20585. Free.

Student Worksheet

THEN AND NOW

Look at this comparison of fuel sources for the United States in 1979 and 1850.

UNITED STATES ENERGY SOURCES



Source: Arkansas Energy Office

Answer the following questions about the charts:

1. What was the only fossil fuel used in 1850?
2. What fossil fuels were used in 1979?
3. In 1850 the most common occupation was farming. Most of the energy for transportation and field work came from
   ____
4. In 1850 homes were usually heated by ______________________________
5. In 1979 most homes were heated by ______________________________
6. Water was pumped by ______________________ in 1850.
7. In 1850 there were few factories and these were mostly fueled by __________
8. In 1850 ____% of all fuel sources were renewable.
9. In 1979 ____% of all energy sources were renewable and ____% were nonrenewable fossil fuels.
10. Use these charts to explain why we are in an energy dilemma today.

Student Worksheet

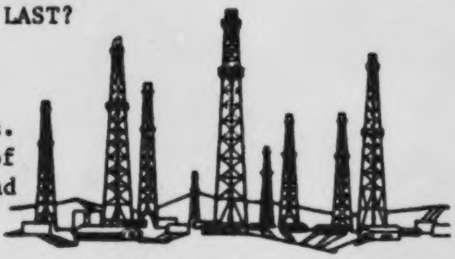
THEN AND NOW

ANSWER SHEET

1. Coal
2. Oil, natural gas, and coal
3. Work animals
4. Wood
5. Natural gas
6. Wind
7. Wood
8. 93%
9. 4.2%, 95.8%
10. The United States is leading the world in using up nonrenewable fossil fuels.

Student Worksheet

HOW LONG MIGHT OIL AND NATURAL GAS IN ARKANSAS AND THE UNITED STATES LAST?



Both petroleum and natural gas are fossil fuels. Like coal, they were formed by chemical changes of ancient plants and animals over millions of years and trapped in rock layers of earth.

Gasoline that runs our cars, trucks and planes is made from petroleum. So are paints, insecticides, fertilizers and many other manufactured proudcts. Natural gas is a clean-burning fuel that heats many homes, cooks food and serves industry. Together oil and natural gas supply 73 percent of the total energy needs for the United States, and 83 percent for Arkansas.

The cheap and easily-exploited domestic oil and natural gas have already been burned. Oil and natural gas resources are declining. The world will run out of oil and natural gas in the next decade or two or three, or at some not yet determined point in the next century. Just when depends on a host of supply and demand variables. But, while the oil and natural gas resources are diminishing, human population will continue to grow, industrialization will continue to increase and developing nations will demand an increasing share of the earth's resources.

Read the following items; then try to determine how long oil and natural gas might last, both in the United States and Arkansas.

1. During 1979, the United States produced about 3,108,000,000 barrels of oil (a barrel holds 42 gallons). Arkansas, during 1979, produced about 18,869,000 barrels of oil.

2. As of January 1, 1979, proved oil reserves in the United States (those known to exist and to be recoverable) were 27.8 billion barrels. As of January 1, 1979, Arkansas had 315,000,000 barrels. At the present rate of consumption in Arkansas, this reserve would last four years.

3. Many geologists estimate that, for the United States, an additional 50 billion barrels of oil exist.

4. The highest estimate is as much as 127 billion barrels of additional domestic oil still undiscovered in the United States.

If this amount of oil still in the ground was the total amount remaining, and if production of oil were not increased or decreased, in about how many years would the United States and Arkansas run out of domestically produced oil? Calculate on the next page.

Student Worksheet

HOW LONG MIGHT OIL AND NATURAL GAS LAST?

United States

(#2) _____ billion barrels
+(#3) _____ billion barrels

_____ billion barrels
÷(#1) _____ billion barrels

_____ Number of years

Arkansas

(#2) _____ billion barrels
÷(#1) _____ billion barrels

_____ number of years

If item #4 on Worksheet 10.7 is true, and if production of oil is not increased or decreased, how many years might the possible total oil resources in the United States last?

In the same way, determine how long natural gas resources for the United States and Arkansas might last.

5. During 1979, the United States produced for use about 18,830 trillion cubic feet of natural gas. During 1979, Arkansas produced .112198 trillion cubic feet of natural gas.
6. The proven reserves of the United States, at the end of 1979, were 194,000 trillion cubic feet of natural gas. The reserves for Arkansas, in 1979, were 2,122 trillion cubic feet.
7. Possible reserves of natural gas for the United States are about 332 to 655 trillion cubic feet.

Using these amounts, calculate about how many years the supply of natural gas in the United States and Arkansas will last.

The United States is now using, each year, almost double the oil that it produces from its own reserves, and Arkansas imports two-thirds of the oil it uses per year. Where does this additional oil come from?

What could happen if our usage contines to increase each year?

What if oil and natural gas usage increases in other nations?

At what time in your life could the United States and Arkansas run out of oil and natural gas?

Source: Pennsylvania Department of Education, Arkansas Energy Office

Student Worksheet

HOW LONG MIGHT OIL AND NATURAL GAS LAST?

ANSWER SHEET

Discounting item #4 on Student Worksheet 10.7, the United States will run out of oil in about 25 years; Arkansas in about 17 years.

Taking item #4 into account, the United States will run out of oil in about 66 years.

The United States will run out of natural gas in about 11 years; Arkansas in about 19 years.

Purchased from other nations

Buy more or run out sooner

Competititon for supplies will increase; prices will rise

Answers vary

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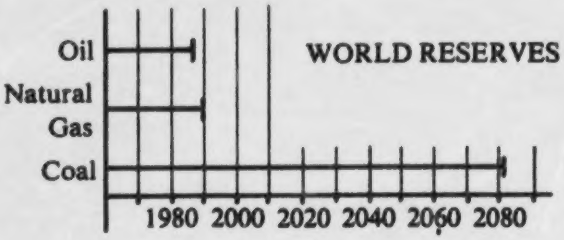
Student Worksheet

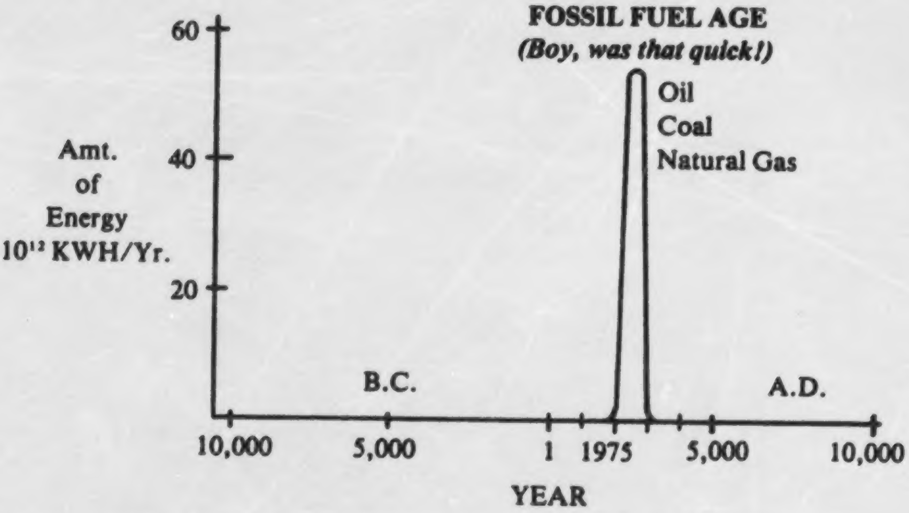
HOW MUCH TIME?

How much is left? How much time? Well, people disagree on how much time is left before our fossil fuels run out. They do all agree on one thing -- the the costs of oil, natural gas and electricity are going up.

Here is a rough idea of when the earth's finite energy resources will run out if present rate of usage continues. Look at the graph, then write in the missing figures:



By about the year ____, all of the ___ and ___________ will be used up. By about the year ____, all of ____, the most abundant fossil fuel will be gone. These nonrenewable sources account for ____% of the energy sources used in 1979 in the United States, and __% of those used in Arkansas.



List three reasons why there is an energy crisis today.

What do you think about the energy crisis?
Is it time to push the button yet?

Student Worksheet

HOW MUCH TIME?

ANSWER SHEET

By about the year 2000, all of the oil and natural gas will be used up. By about the year 2080, all of coal, the most abundant fossil fuel will be gone. These nonrenewable sources account for 92.3% of the energy sources used in 1979 in the United States, and 86% of those used in Arkansas.

1. Dependence on energy sources that are nonrenewable. The use of these sources at 200 times the speed they are being made.
2. Energy demands keep increasing as population grows.
3. Much waste of energy.

Note: The x-axis of the energy graph is logarithmic, whereas the y-axis is arithmatic

Student Worksheet

PROBLEMS, PROBLEMS, PROBLEMS

Answer these questions yourself; then cast yourself in the role of newspaper reporter and interview an adult in your community (it can be a parent) about these problems. Make up at least one question of your own under each heading. If you need more space, use the back of this sheet.

	Your Answer	Adult in Community
ENVIRONMENT		
1. Have you ever had a cough or stinging eyes because of air pollution? How did it make you feel?		
2. Do you know if anything is being done in your community to make the air cleaner.		
3. (Your question)		
LIMITED SUPPLY		
1. Where in the world are the greatest deposits of fossil fuels found?		
2. What nation in the world uses the most coal; the most petroleum?		
3. Is it possible to make oil once it is gone?		
4. (Your question)		
COST		
1. Name three fossil fuel products whose price has increased this year?		
2. (Your quesetion)		
CONSERVATION		
1. How can we make the supply of fossil fuel energy last longer?		
2. (Your question)		

Source: United States Department of Energy

LESSON #11

CATEGORY: Limits

TITLE: The Energy Crisis:
Is it Real?

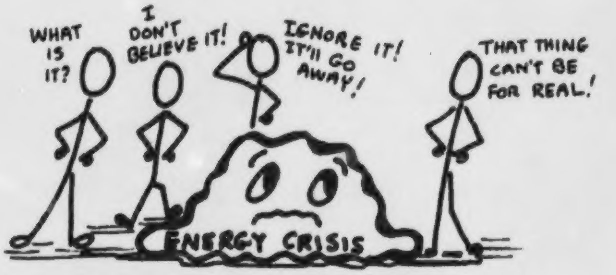
INFUSE WITH SUBJECT AREA:
Social Studies
Reading

MATERIALS:
Paper
Crayons or magic markers
Arkansas reference materials

ENERGY TYPE: All

GRADE LEVEL: 7-10

TIME NEEDED: Two-Four periods


WHAT IS IT?
I DON'T BELIEVE IT!
IGNORE IT! IT'll GO AWAY!
THAT THING CAN'T BE FOR REAL!
ENERGY CRISIS

OBJECTIVES:

1. The students will compare energy resources to energy uses.
2. The students will become aware of the source of most of the energy used in Arkansas and the United States.
3. The students will discover the relationships between energy shortage and the life of a community.
4. The students will discover the relationships between the life styles of Arkansans and their use of energy.

TASK ANALYSIS:

The students should be able to read graphs; do independent research and report on that research.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 11.5 - 11.10.
   Gather above-listed materials.

2. Steps in Lesson
   Objective #1: The students will compare energy resources to energy uses.

   a. Say to the students: "Today you will be brain-storming the uses and sources of energy. These are the rules for brainstorming."
      -Any idea is acceptable
      -Feel free to piggyback on another idea
      -It is important to have a lot of ideas
      -Speak right up
      -Do not evaluate any idea, e.g., "That's a good/bad idea"
      -No commercials or explanations, e.g., "We should use that idea because..."

   b. Say: "Name as many different uses of energy in our society as you can." Define energy as "the ability to do work; to accomplish a task." List these uses on the chalkboard; do not edit. Allow up to 10 minutes.

c. Say: "Name any energy sources used in Arkansas or the United States." List these sources on the chalkboard; do not edit. Allow up to 5 minutes.

d. Have the class categorize energy uses by type. They may categorize into transportation, consumer use, household use, industrial use, etc. Let the students decide on their own categories.

e. Have the class decide if there are other ways in which to use energy which we do not use at this time because of the high cost or unavailability of the energy. The students should be able to generate many suggestions here because wants are unlimited, and they can think of new ways to use energy.

f. Have the class categorize energy sources by type. They may categorize energy sources by type. They may categorize into fossil fuels versus non-fossil fuels, renewable versus nonrenewable, etc.; let them make their own categories.

g. Ask: "Why aren't these energy sources used to satisfy all our energy desires (wants)? (Because they are limited and can not provide all the energy we want to use; our energy wants are unlimited but our energy resources are limited.

h. Discuss the following statements:
- The desire to use energy is unlimited while the resources available that produce energy are limited.
- Energy represents a resource which is scarce and is experiencing an increasing demand.
- Consumers purchase energy because they receive benefits equal to or greater than other things they could purchase with the same money. (Opportunity cost).

Objective #2: The students will become aware of the source of most of the energy used in Arkansas and the United States.

a. Hand out Student Worksheets 11.5 - 11.6. Discuss the Worksheets and answer the questions in class.

Objective #3: The students will discover the relationships between energy shortage and the life of a community.

a. Ask: "Who is to blame for the energy shortage?" Discuss the students' answers and the reasons for their opinions. (It will soon become obvious that there is no one answer; no one is to blame -- everyone is to blame. We are all, in some way, responsible. As Pogo says, "We have met the enemy and he is us."

b. Have the students make a list of the people or events they thought were to blame for the energy shortage. (Presidents, Congress, Secretarys of Energy, Iranian revolution, Mid-East situation, increasing population, limits to oil supply, greed, waste, too many cars, etc.).

c. Investigate each of the items on the list.

d. Ask: "Why is it so difficult to get a national energy policy?" (Most people do not really believe there is an energy shortage; many diverse groups and interests to satisfy; too politically dangerous).

e. Survey community reaction to the energy crisis. Have the students ask:
- Is there an energy crisis?
- Who is to blame for the energy shortage?
- What should governments be doing about the energy shortage?
- Do you have a personal commitment to energy conservation?

Objective #4: The students will discover the relationships between the life styles of Arkansans and their use of energy.

a. Divide the class into six groups. Hand out Student Worksheet 11.7 showing the natural divisions of Arkansas. Let each group choose one of the natural divisions to represent.
b. Have each group research and give a brief report on energy supply and use in the assigned division (be sure not to overlook human power). The groups should:
   >Collect pictures and newstories from Arkansas magazines and newspapers and use them to prepare a bulletin board display.
   >Investigate patterns of energy supply and use in rural, suburban and urban areas.
   >Consider such factors about their division as:
   -population
   -education level
   -occupations
   -transportation
   -industries
   -agriculture
   -topography
   -urbanization
   >Use information souces such as:
   -Arkansas magazines and newspapers
   -The Arkansas Natural Area Plan. Arkansas Department of Planning: Little Rock. 1974
   (A copy should be in each school library.)
   -Arkansas and Energy: A Look at the Alternatives. Paul L. Butt. Arkansas Ecology Center: Little Rock. 1979.
   -The Natural Divisions of Arkansas. Thomas L. Foti. Arkansas Ecology Center: Little Rock. 1978.
   -Reading the Environment. William L. Fulton. Arkansas Department of Education: Little Rock. 1978.
   -Environmental Impacts of Economic and Population Change in Arkansas. Thomas Graff, Phillip Besonen, Thomas McKinnon. University of Arkansas: Fayetteville. 1977.
   -Arkansas history books
   -The legislators, county judges and chambers of commerce of county seats within the assigned division.
c. If you wish, hand out Student Worksheets 11.8 - 11.9 for student research use.
d. After all the presentations have been made, have the class discuss the fact that the use of energy is based on many variables, not the least of which is the people themselves.

3. Evaluation

Use one of the following exercises to evaluate student understanding of the relationships between human actions and the energy situation.

a. The Energy Scenario on Student Worksheet 11.10.
b. Arkansas Monopoly as follows:

   "Arkansas Monopoly"
   >Divide the class into six groups; each group controls all of one of the following Arkansas resources:
   -wood
   -oil

-natural gas
-coal
-nuclear power
-hydropower

>Ask each group to meet to consider how it would use its monopoly of one resource within the state. (To exert power or influence on the rest of the state, to share with all or part of the state, etc.).

>Have each group present its plan to the class. (You will be able to judge the time allotted by the interest shown in the preparation of the group presentation).

>Discuss any apparent conflicts which may have to be resolved.

Optional:

>Form a committee of one member from each group to meet to discuss any possible compromises that might be worked out to resolve conflicting positions.

>Have the committee report to the class, and discuss the committee proposal.

>Ask: "What happens if the conflicting plans cannot be resolved in committee? (Government intervention; appointment of a new committee; shortage of one or more resources for the state; war).

4. Follow-Up Activities

Read the following French children's riddle, which concerns a pond, a farmer and a water lily:
The lily is doubling in size every day. In thirty days, it will cover the entire pond, killing all the creatures living in it. The farmer does not want that to happen; but being busy with other chores, he decides to postpone cutting back the plant until it covers half the pond. The question is:
On what day will the lily cover half the pond?
The answer is: On the twenth-ninth day, leaving the farmer only one day to save his pond.

Ask the following questions:
-What does this riddle have to do with the enery situation?
-Is Arkansas and/or the United States now in the "twenty-ninth day" as far as the energy situation is concerned?
-Is there a limit to growth?
-If so, what really determines the limit? (Energy).

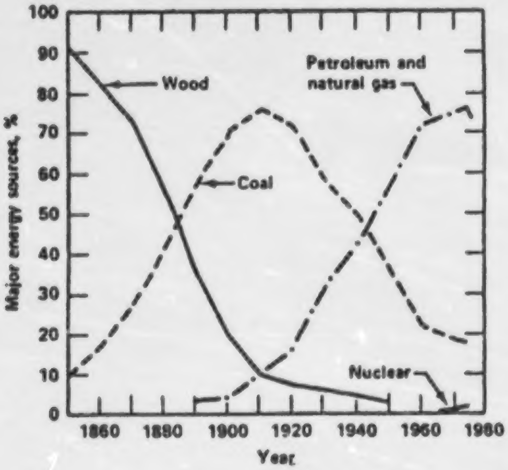
Optional:
-What happens when industrial output grows faster than population? (Rising standard of living; more products for each person).
-Discuss how this has affected the development of cities.
-What happens if population doubles and agricultural production does not? (Hungry people).

Student Worksheet

ENERGY SOURCES

The United States, which accounts for about one-third of the world's total energy consumption, relies most on its scarce domestic energy resources and least on its abundant ones. The nation has an energy problem because about 73 percent of its energy comes from oil and natural gas. Coal, our most plentiful fossil fuel, currently supplies less than 20 percent of our energy needs. Uranium provides 3.5 percent of our energy and hydropower 4 percent. The present contribution of direct solar energy is neglibible.

HISTORICAL U.S.
ENERGY CONSUMPTION PATTERNS



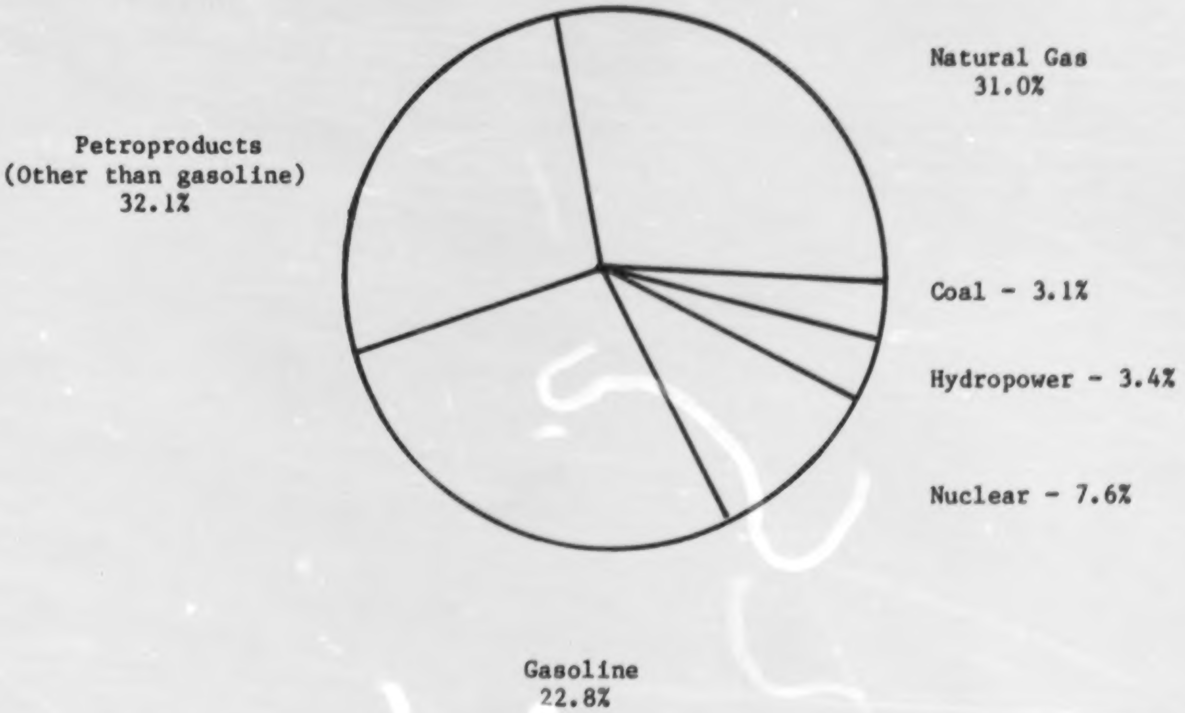
Source: Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

Like the nation, Arkansas relies most on scarce energy resources and least on abundant energy resources. This is the crux of the energy crisis. The problem is not that we are running out of energy, but rather that we are running out of the forms of energy, natural gas and oil, that we have come to depend upon so heavily. Arkansas depends on these two resources for 83 percent of its energy. Coal and nuclear provide about 11 percent of Arkansas' energy; hydropower 3.4 percent. The contribution of direct solar energy in Arkansas is negligible, though growing.

The energy dilemma that now faces Arkansas and the United States, which is expected to intensify during the 1980's, results from the divergence between an increasing energy demand and a decreasing domestic production of oil and natural gas. To solve its long term energy problem, Arkansas, like the nation, must undergo a major transition from dependence on oil and natural gas to dependence on other energy sources.

Student Worksheet

WHERE ARKANSAS ENERGY COME FROM
1978



Answer the following questions:

1. What type of energy is used most in Arkansas?
2. What percentage of energy consumed in Arkansas comes from nuclear power? Hydropower?
3. What percentage of Arkansas' total energy consumption comes from fossil fuels (coal, oil and natural gas)?
4. Which fossil fuel contributes the least to Arkansas' fuel mix?
5. Why is Arkansas facing an energy dilemma today?
6. What are some possible solutions to this dilemma?

Source: Arkansas Energy Office

Student Worksheet

WHERE ARKANSAS ENERGY COME FROM
ANSWER SHEET

1. Fossil fuels, specifically petroleum

2. Nuclear: 7.6 percent
   Hydropower: 3.4 percent

3. 89 percent

4. Coal

5. The major portion of Arkansas' energy comes from nonrenewable fossil fuels (coal, oil and natural gas) that are rapidly being depleted.

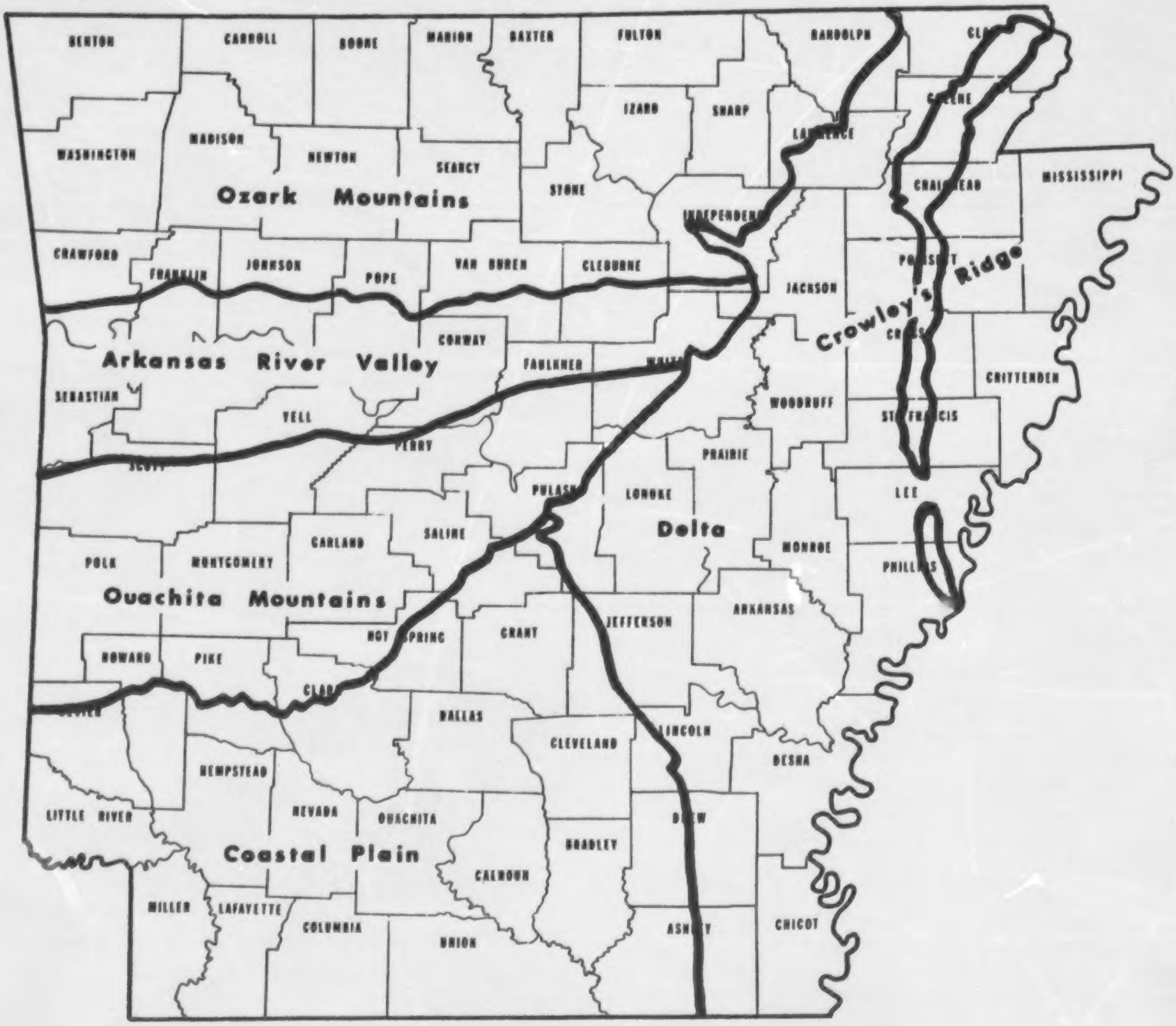
   The most abundant fossil fuel, coal, is the least utilized in Arkansas.

6. Increased use of coal, which is more abundant than oil and natural gas.
   Increased use of renewable resources (hydropower, biomass, direct solar, etc.).
   Conservation of all resources.

Student Worksheet

THE NATURAL DIVISIONS OF ARKANSAS

In Arkansas, there are six major natural divisions: the Ozark Mountains, the Arkansas River Valley, the Ouachita Mountains, the Coastal Plain, the Delta, and Crowley's Ridge:


BENTON
CARROLL
BOONE
MARION
BAXTER
FULTON
RANDOLPH
WASHINGTON
MADISON
NEWTON
SEARCY
IZARD
SHARP
GREENE
STONE
CRAIGHEAD
MISSISSIPPI
Ozark Mountains
CRAWFORD
JOHNSON
POPE
VAN BUREN
CLEBURNE
JACKSON
Crowley's Ridge
CONWAY
Arkansas River Valley
FAULKNER
SEBASTIAN
YELL
WOODRUFF
CRITTENDEN
PERRY
PRAIRIE
LONOKE
LEE
GARLAND
SALINE
Delta
MONROE
POLK
MONTGOMERY
PHILLIPS
Ouachita Mountains
ARKANSAS
GRANT
JEFFERSON
HOWARD
PIKE
DALLAS
CLEVELAND
DESHA
HEMPSTEAD
NEVADA
OUACHITA
LITTLE RIVER
BRADLEY
Coastal Plain
CALHOUN
MILLER
LAFAYETTE
COLUMBIA
UNION
CHICOT

Student Worksheet

ARKANSAS ENERGY NOTES

Imports

-Overall, Arkansas imports 50 percent of its energy needs.
-In 1978, Arkansas imported 15 percent of its electric needs, 52 percent of its natural gas needs and 72 percent of its petroleum needs.

Prices

Natural gas.
-In 1970, the average annual residential bill was $103. In 1978, the average annual bill was $190-an increase of 84 percent. With deregulation, the price for natural gas will rise more dramatically as it starts tracking petroleum prices.

Electric
-In 1971, the average annual residential bill was $147. In 1979, it was $383 - an increase of 160 percent. During the same time period, the average electric bill for large industrial users increased 37 percent.

Gasoline
-Between 1970 and 1979, the average price for a gallon of gasoline increased 146 percent. During the same period, the average prices for other consumer goods increased 87 percent.

Per Capita Impact
-In 1970, payments for energy took 15 percent of Arkansas' per capita income. In 1979, that percentage was 23 percent and rising.

Forecasts

Gasoline
-From 1973 to 1978, gasoline use in Arkansas increased at an average annual rate of about 2-1/2 percent. In 1979, gasoline demand was down 6 percent from demand in 1978 -- the first time since the 1973 OPEC Embargo that demand dropped. Over the next decade, assuming no major supply interruption, gasoline use will continue to decline at an average annual rate of about 2 percent.

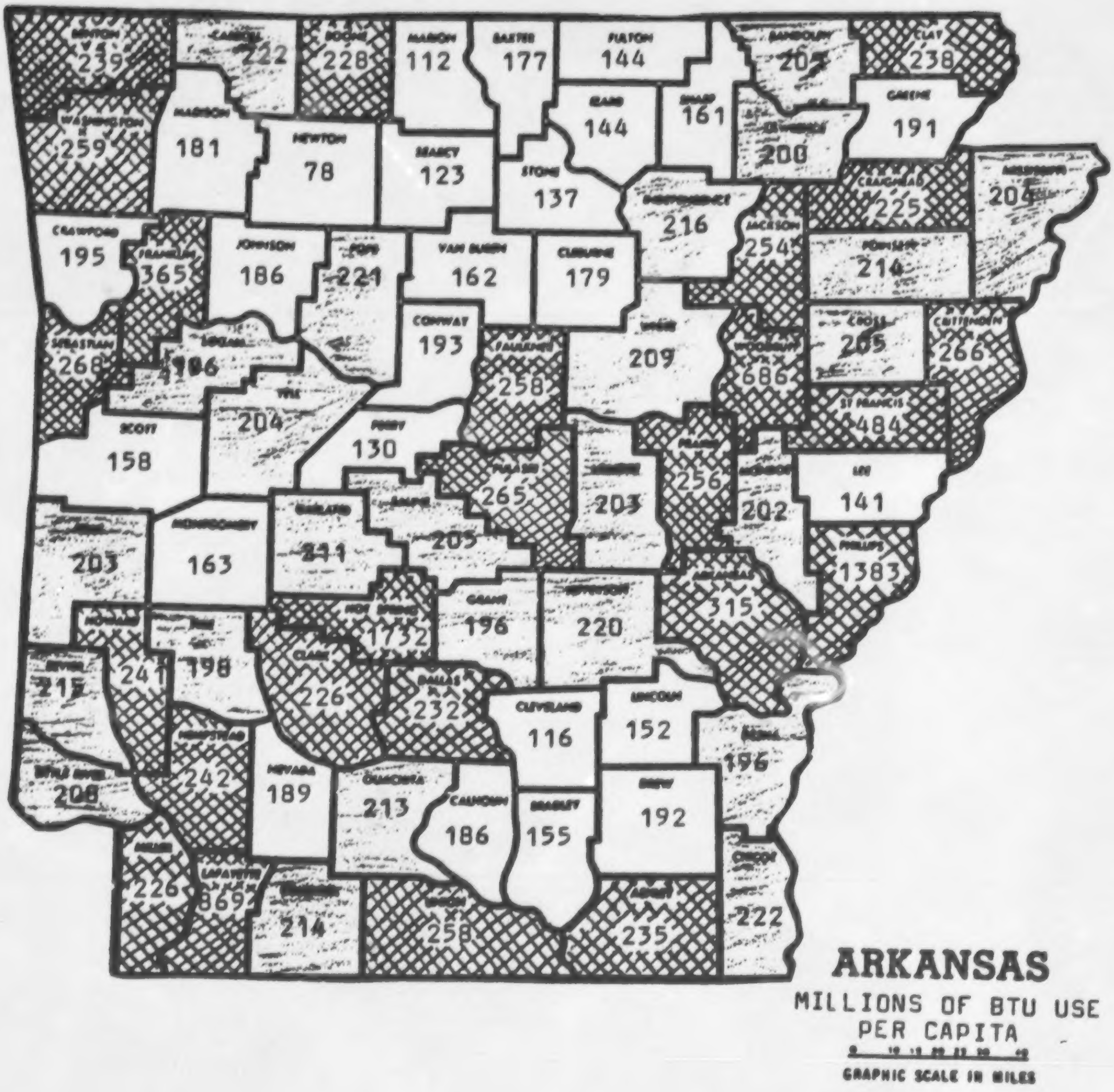
Electric
-From 1973 to 1978, electric consumption increased at a rate of about 3 percent a year. This trend should continue through the next decade.

Natural Gas
-From 1973 to 1978, natural gas consumption decreased at an average annual rate of 8.5 percent, principally because of industrial curtailments and curtailed use of natural gas for electric power generation. Demand should remain level for the next decade.

Source: Arkansas Energy Office

Student Worksheet

ENERGY USE IN ARKANSAS


BENTON
239
CARROLL
222
BOONE
228
MARION
112
BAXTER
177
FULTON
144
RANDOLPH
205
CLAY
238
WASHINGTON
259
MADISON
181
NEWTON
78
SEARCY
123
STONE
137
IZARD
144
SHARP
161
LAWRENCE
200
GREENE
191
CRAIGHEAD
225
MISSISSIPPI
204
INDEPENDENCE
216
JACKSON
254
POINSETT
214
CRAWFORD
195
FRANKLIN
365
JOHNSON
186
POPE
221
VAN BUREN
162
CLEBURNE
179
WHITE
209
CROSS
205
CRITTENDEN
266
SEBASTIAN
268
LOGAN
196
CONWAY
193
FAULKNER
258
WOODRUFF
686
ST FRANCIS
484
YELL
204
PERRY
130
SCOTT
158
PULASKI
265
LONOKE
203
PRAIRIE
256
MONROE
202
LEE
141
POLK
203
MONTGOMERY
163
GARLAND
241
SALINE
205
PHILLIPS
1383
HOT SPRING
1732
GRANT
196
JEFFERSON
220
ARKANSAS
315
HOWARD
241
PIKE
198
SEVIER
215
CLARK
226
DALLAS
232
CLEVELAND
116
LINCOLN
152
DESHA
196
HEMPSTEAD
242
LITTLE RIVER
208
NEVADA
189
OUACHITA
213
CALHOUN
186
BRADLEY
155
DREW
192
MILLER
226
LAFAYETTE
869
COLUMBIA
214
UNION
258
ASHLEY
235
CHICOT
222
GRAPHIC SCALE IN MILES

ARKANSAS

MILLIONS OF BTU USE
PER CAPITA

Average 277 ▦
"Top 25": 225-1732
"Mid 25": 196- 222 ▨
"Low 25": 78- 195 □

Data are for 1976

Source: Brookhaven National Laboratory

Student Worksheet

ENERGY SCENARIO

Seven oil companies control the major domestic and foreign production of petroleum products in the United States.

Because of dramatic price increases by the OPEC nations in the past few years, these companies are reaping windfall profits.

A national debate concerning these profits is currently being waged with these major proposals:

(a) Free market solution.
Advocates of this proposal believe the oil companies should have free will in determining the price of petroleum products, and the profits the oil companies make would probably be used to explore new oil fields and develop new ways of getting oil from less productive fields.

(b) Taxing windfall profits.
Windfall profits would be taxed by the federal government, or possibly the state governments, and these taxes would be used to help the needy with fuel bills and provide funding for conservation and alternate fuel resources.

(c) Nationalization of the oil companies.
The companies would be bought by the federal government and all profits would be used as congress determines.

(d) Regulation as utilities.
The companies would be regulated by a commission, which would have to approve price increases, and profits in a manner similar to the way the Public Service Commission regulates utilities in Arkansas.

Problem:

Each of you are members of the U.S. House of Representatives. Choose from, debate, and pass one of the above proposals, or a solution of your own to deal with Windfall Oil Company profits.

Source: Arkansas Energy Office

LESSON #12

CATEGORY: Alternatives

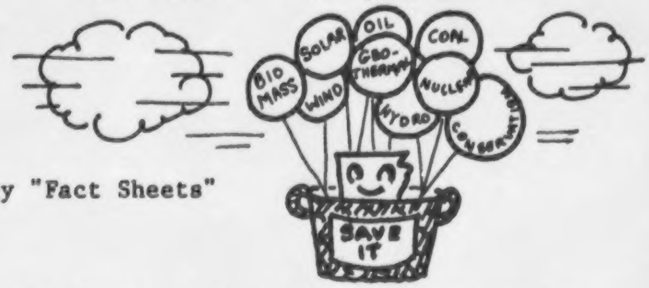
ENERGY TYPE: Alternative Energy Sources

TITLE: Beyond Fossil Fuels

GRADE LEVEL: 9-12

INFUSE WITH SUBJECT AREA:
Science
Social Studies
Reading

TIME NEEDED: Three periods



MATERIALS:
Optional:
United States Department of Energy "Fact Sheets"

OBJECTIVES:

1. The students will recognize the increasing need for energy sources other than fossil fuels.
2. The students will be able to list some criteria by which we should judge future energy sources.
3. The students will be able to list some energy sources which are alternatives to using fossil fuels and state an advantage and a disadvantage of each.
4. The students will make choices on the sequential order in which alternative energy sources should be developed.

TASK ANALYSIS:

The students should be able to read informational material, then answer questions on that material; be able to do independent research and report on that research.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 12.11 - 12.17.
   Read Teacher Background Information (12.5 - 12.10)
   (Optional): Order "Fact Sheets" from: United States Department of Energy -- Technical Information Center, Box 62, Oak Ridge, Tennessee 37830. "Fact Sheet" titles: Fuels from Plants (Bioconversion); Fuels from Wastes (Bioconversion); Wind Power; Electricity from the Sun I (Solar Photovoltaic Energy); Electricity from the Sun II (Solar Thermal Energy Conversion); Solar Heating and Cooling; Geothermal Energy; Breeder Reactors; Nuclear Fusion; New Fuels from Coal; Alternative Energy Sources: Environmental Impacts.

2. Steps in Lesson
   Objective #1: The students will recognize the increasing need for energy sources other than fossil fuels.
   a. Hand out Student Worksheets 12.11 - 12.13. Have the students read and discuss the material, then answer the questions. Discuss the answers in class.

Objective #2: The students will be able to list some criteria by which we should judge future energy sources.

a. Do one of the following activities:

Make the following statement to the class:

"An alternative energy source, Product X, has recently been developed as the result of years of secret research. This energy source will soon be offered to residents of Arkansas as a replacement for conventional energy sources now being used. Before acceptance of Product X, what are some factors you should consider about it as an energy source?"

Write ideas offered by the students on the chalkboard. If necessary, share the following with the students. "Much development is necessary before a laboratory technology can be demonstrated and considered as a usable energy alternative. Some of the factors that should be considered are: Reliability; safety; adverse environmental effects; efficiency; economics."

Discuss the list.

Explain to the students that the following three questions are ones that should be considered regarding the development of any energy source for the future. Place the three questions on the chalkboard and have the students discuss each.

-How much energy will be needed to develop the energy source? (Remind students that some energy systems use more energy than they produce.)

-How much will the environment be affected now and in the future by using the source. (You may give the following examples: Coal as a source of natural gas and oil will require strip mining; nuclear fission reactors produce harmful wastes that will last for thousands of years).

-Who has control over the energy system? (You may mention the following options: Private ownership, government ownership, foreign control. Remind students of the problems resulting from OPEC's control of the world's oil.)

After the above discussion, request that the students write down what energy source they feel is best for the future, based on ideas generated by the three questions. Tell them to be prepared to defend their choice. Discuss the choices in class.

b. If you wish, share the following ideas with the class. Today's energy sources came into wide use because they were relatively cheap, abundant, and efficient. The attractiveness of any alternate energy sources will increase if the sources we are now using continue to become more expensive and scarce. It seems that no promising source of energy, however unconventional it may be, should be neglected by a nation and a world that is so dependent on a supply of energy and so unsure of the length of time that supply will last. The best approach for coping with the energy crisis is immediate conservation of our existing energy resources and use of more direct energy systems based on renewable energy sources in the future. These two approaches will require the least energy, will do the least damage to the environment, and they will allow us to maintain the most control over our own energy.

Objective #3: The students will be able to list some energy sources which are alternatives to using fossil fuels and state an advantage and a disadvantage of each.

a. Hand out student Worksheets 12.14 - 12.15. Have students read and discuss the material.
b. If you wish, share the material found on Teacher Background Information 12.5 -12.9 with the students.
c. Place the chart on Teacher Background Information (12.10) on the chalkboard or overhead. Have the students fill out and discuss the chart as a group.

Objective #4: The students will make choices on the sequential order in which alternative energy sources should be developed.
a. Divide the class into groups of 2-3 students per group. Try to have a range of abilities in each group.
b. Assign each group one of the energy resources that has been discussed in class, such as: direct solar, wind, geothermal, etc.
c. Explain to the students that they are to research this energy source, then report to the class their findings. Each student will read any books, newspapers, magazines, etc. available to gather data.
d. Hand out and discuss Student Worksheet 12.16.
e. After the Worksheets are completed, have each group present its findings to the class.
f. Tell the class they will be asked to determine an energy budget for the coming year. The students should utilize the information acquired by the various groups to develop a workable and acceptable budget.
g. Break the class up into groups of 6-10 students each. Hand out Student Worksheet 12.17. Have each group work out an energy budget, then present its budget to the class.
h. Discuss the various budgets presented. If you wish, the class may vote on one of the budgets to adopt as class policy.
i. Appoint a class committee to incorporate the student budgets into a letter to be sent to the governor of Arkansas, the Arkansas Energy Office and/or the United States Department of Energy.
j. Have the students write to their congressmen and senators expressing satisfaction or dissatisfaction with the federal government's energy policy.

3. Evaluation

Oral evaluation of student knowledge during class discussions.

Check answers to student worksheets.

Have the students write a statement on their choice of future energy sources, listing advantages and disadvantages.

Have the class debate on the merits of one, or all, of our possible future energy sources.

4. **Follow-Up Activities**

Have the students design a home for the future, utilizing one of the discussed energy sources.

Have students design and construct models of possible future energy-producing or -collecting devices using alternative energy sources.

Take a field trip to: a hydroelectric power facility, a coal generating plant, a waste conversion plant, a solar home, an oil well, an area displaying geothermal possiblilities, or a working windmill.

TEACHER BACKGROUND INFORMATION

Sources:

Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

Pennsylvania's Energy Curriculum for the Middle Grades. Pennsylvania Department of Education: Harrisburg. 1977.

SOME ALTERNATIVE ENERGY SOURCES

FOSSIL FUELS:

Fluidized-Bed Combustion of Coal

Coal is by far the nation's most extensive fossil fuel resource, one on which we may have to rely heavily. Coal has not been a significant part of the Arkansas energy mix in the recent past, but with dwindling supplies of oil and natural gas, coal will probably become an increasingly important component of the state's fuel mix. Research is underway on new ways to burn coal cleanly. One of the possibilities is fluidized-bed combustion of coal, in which pulverized coal is burned in the presence of limestone. Sulfur from the coal is captured in the limestone, and the temperatures of combustion are low enough that formation of nitrogen oxides is minimized. The solid residue from the process may have value as an agricultural nutrient.

Magnetohydrodynamics (MHD)

Magnetohydrodynamics is a method of generating electricity by passing hot combustion gases from burning coal through a magnetic field at high speed. MHD plants would be much more efficient than convetnional coal-burning plants, and would produce less pollution. Many engineering problems remain to be solved, but this method does show promise.

Coal Gasification

By using high temperature and pressure, coal can be converted into a gas very much like natural gas. Building these conversion plants near coal fields can solve the problem of transporting bulky fuel that gives off pollutants when it is burned. When coal gas is burned, it burns as cleanly as natural gas with almost no air pollution. A major environmental concern with this process is getting the coal out of the ground. Tremendous amounts of coal would be required (about 605 tons an hour per plant). Much would be strip-mined from Western coal deposits. Without reclamation, which would add to the cost of the gas produced, large areas of western land could be devastated. Another problem would be water for processing, which is not always available where the most promising coal deposits lie. The conversion process itself uses large amounts of electrical energy, and creates a thermal pollution problem.

Coal Liquefication

Coal can also be converted into an oil-like liquid. It has the advantage over coal gas of being usable to make all the usual oil products, including gasoline to run our cars. Techniques to accomplish this are now being studied, but are not as far along as gasification techniques. The environmental considerations for liquefied coal are generally the same as for coal gasification, except that water requirements will probably be even greater.

Oil Shale

Oil shale is a finely textured rock containing a tarlike material called "kerogen." When melted, kerogen gives off vapors that can be converted to shale oil. This oil can then be refined into oil, gasoline and other petroleum products. United States oil deposits are primarily located in the West; however oil shales appear to occur throughout the Arkansas Ozarks. It is thought by some of the nation's leading petroleum geologists that some Arkansas oil shales are as high in quality, if not better, than the oil shales of the Rocky Mountains region. One ton of rock will produce about 25 gallons of oil. The rock must be mined, either by deep mining or surface mining. Extraction takes about 3 barrels of water to every 1 barrel of oil processed. Another problem is the disposal of the spent rock after extraction. Vegetation will not grow on the used shale without moderate rainfall, scarce in many parts of the West. Without vegetation, some animals will lose their homes and food supply. Rain passing through the rock may pick up pollutants and carry them into the larger water bodies if there is no vegetation. In addition, oil shale processing contributes to air pollution. Opposition by the recreation-tourism sector of Arkansas will likely be a major deterrent to the development of the state's oil shales. The shales are located in some of the most scenically attractive areas of Arkansas, an important income generator for the state.

Tar Sands

In southwestern Arkansas, black, high-sulfur, molasses-like tar termed "bitumen" impregnates fine sands. The bitumen can potentially be extracted from the tar sands by heating and flotation, and then purified and upgraded to synthetic crude oil. But the economic cost of extraction versus market selling price will likely deter the development of the Arkansas tar sands.

INTERNAL EARTH ENERGY:

Geothermal Energy

The earth's interior is a molten mass. In some areas this mass is close to the surface. Some evidence of this is volcanos, geysers and hot springs. This heat can be tapped by drilling into the earth and turned into usable energy by running turbines to generate electricity. In most locations the hot interior mass is too deep to reach with existing drilling technology, but in some areas, including a large part of the Ouachita Mountains of West Central Arkansas, large heat sources occur relatively close to the surface. At present, the only large-scale geothermal power generation complex in the United States is the Geysers Fields in California. Scientists are searching for other areas where this geothermal energy can be reached. The United States Department of Energy recently conducted a preliminary survey (not in-field) of geothermal activities and potential in Arkansas.

Earth Sheltered Structures

Another aspect of geothermal is the earth-sheltered structure: taking advantage of the thermal properties of the earth to insulate a structure (maintaining a constant temperature). Geothermal can also be used to cool: piping cool (55 degree) air from below-ground up into a surface structure. These methods have considerable potential in Arkansas; however, geothermal energy is not expected to play a major role in Arkansas' foreseeable energy future.

SOLAR:

Direct Solar

Direct solar energy has an impressive array of advantages over other energy sources. It is an essentially unlimited and readily available energy source. The amount of solar energy that reaches the earth's surface in two weeks is equivalent to the energy in all known fossil fuel reserves. Direct solar is the cleanest and safest of all energy sources. With solar energy the major release of heat occurs in the sun, thus avoiding heat build-up in the atmosphere. No major breakthroughs are needed to make direct solar energy technologically feasible. Solar energy takes many forms. It can be tapped through innovative architectural design, it can be gathered by collectors for heating and cooling, it can be concentrated for intermediate and high-temperature applications, it can be converted directly into electricity. Along with its many advantages, direct solar energy has some problems. The solar energy falling on the earth's surface is so widely dispersed that collecting and concentrating it present difficulties. Like most dispersed energy tenchologies, direct solar is resource intensive (copper, aluminum, glass). Another problem is that the supply of direct solar energy varies with weather and climatic conditions. The collecting and backup equipment can be quite costly initially. But in terms of lifetime cost, direct solar energy is economically attractive in Arkansas.

Indirect Solar

Wind Power

Wind is an almost inexhaustible, renewable, clean, and safe energy source that has a moderate net useful energy yield and is based on developed technology. Wind energy in a windy area can be tapped 24 hours a day. Wind is an indirect form of solar energy, caused by the uneven heating and cooling of the earth's surface, that can be converted by wind turbines to mechanical energy and to electricity. The total amount of potential energy in the wind is tremendous. It is theoretically possible to harness as much as 60 percent of this energy. Extensive use of wind energy today has been held back by several factors: wind energy is not economically competitive with conventional energy sources; wind does not always blow where and when it is desired; energy storage techniques need to be improved for use in periods of calm; wind turbines dotting the landscape will create some visual pollution. Wind power will probably not provide a large part of the total Arkansas energy requirements because of its variability. However, wind power could provide supplemental energy for rural homes and agriculture, where it is suitable for providing power for irrigation systems.

Biomass

Organic matter such as trees, agricultural and forestry residues, aquatic plant life, and animal and urban wastes represents a great potential as an energy source. Organic matter is collectively known as "biomass." Biomass is considered to be a solar-related energy source because all organic matter depends upon sunlight and the photosynthesis process. Biomass can be most readily converted to energy by burning, or direct combustion. Other techniques produce fuels from biomass ("biofuels"). These include: Gasification and liquefication to make natural gas-like and petroleum-like products; anaerobic digestion, or treating biomass by certain bacteria to produce a synthetic gas; and fermentation to produce gasoline substitutes. Biomass energy has several advantages: it is renewable, there is no storage problem, and there is less air pollution than is caused by the burning of conventioanl energy sources. A limiting factor to using biomass may be its low net useful energy yield.

Hydropower

Falling water in streams can provide a renewable energy resource by passing it through turbines which spin generators to produce electricity. Hydroelectric power plants are highly efficient and have a high net useful energy yield. They do not significantly consume water, heat the water of streams, or contribute to air pollution. After using its motive force, the water is returned unharmed to the stream to perform other tasks downstream. In addition to generating electricity, many hydropower projects serve other purposes such as flood control, navigation, irrigation, and recreation. Large-scale development of hydroelectric power is limited by suitable site availability. Only the northwestern half of Arkansas generally provides variations in elevation sufficient for hydropower development. Large-scale hydroelectric installations harm the environment by lowering water levels, submerging land and requiring transmission lines and towers. A sustained period of rainless weather can reduce the generating capacity of hydropower. However, with proper management techniques and equipment, hydro can play an important role in an integrated system of electrical generation.

NUCLEAR PROCESSES:

Liquid Metal Fast Breeder Reactor

The breeder reactor is cooled with liquid sodium instead of water. It actually produces (breeds) additional fuel as it makes heat for electricity. The fuel is a mixture of uranium and plutonium. The plutonium can be fissioned, and in the process, neutrons stike the nuclei of the uranium and produce more fissionable material, including plutonium. The breeder reactor would be more efficient than today's reactors, produce less waste heat and reduce the escape of radiation into the air and water. Problems could occur with the sodium coolant, which will burn if exposed to water or air. It requires an elaborate heating system and will become intensely radioactive. Some people feel that an accidental power surge could lead to an uncontrolled chain reaction which could explode the reactor and release dangerous amounts of radiation. The major controversy is over the plutonium produced by the reactor. Plutonium can be made into nuclear weapons, is extremely poisonous and is a radioactive substance with a very long half life. Thus it must be handled and stored under very controlled conditions.

Fusion

In the process of nuclear fusion, two light nuclei are forced together under extremely high temperatures and pressures to form a heavier nucleus, and a small amount of their mass is converted into a tremendous amount of energy. Scientists have been working for 30 years to control fusion as a power source. No one has yet been able to produce a confinement field that will hold together for an appreciable length of time. There are many engineering hurdles to be leaped before commercial fusion power is a reality. Fusion appears to be a 21st century energy source.

CONSERVATION

If the energy conservation habits of Arkansans are reflective of those of the nation, and there is no reason to believe otherwise, about half the energy used in Arkansas is wasted. This staggering amount could be saved through energy conservation. The cheapest potential source of energy available today is that which can be obtained by using less. Technically, conservation is not a source of energy. Rather than providing energy itself, conservation reduces the use and waste of energy resources. Not only is conservation the cheapest source of energy, potentially saving Arkansas consumers millions of dollars each year, but it also lessens the environmental threats posed by other energy technologies; extends the supplies of natural gas and oil; buys time to develop other energy alternatives; lessens our dependence on foreign oil; improves the nation's balance of payments position; and reduces the nation's vulnerability in foreign affairs.

Place the following chart on the chalkboard or overhead.

Energy Source	Direct Use		Renewable	Minimally Polluting	Future: Last How Long?	Cost: Fixed or Rising	Sum of No. Values (Total Points)
	Heat	Electricity					
# Value							100
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							

1. Have the students discuss the characteristics across the top of the chart (renewable, minimally polluting, future, etc.).
2. Have the students assign a number value to each of the characteristics, indicating its relative importance in their minds. The maximum sum of the number values will be an arbitrary 100 points. This sum of 100 points will indicate a "perfect" score for an energy source.
3. Have the students list as many energy sources as possible, filling them in on the chart as they go.
4. List the characteristics for each energy source, checking the ones that pertain to each.
5. Add the total points for each source, remembering that the closer to 100 the sum is, the better the energy source.
6. Discuss the results.

Below is a sample of a filled-in chart. Each chart will be different, depending on the class.

Energy Source	Direct Use		Renewable	Minimally Polluting	Future: Last How Long?	Cost: Fixed or Rising	Sum of No. Values (Total Points)
	Heat	Electricity					
# Value	5	5	10	30	40	10	100
1. Nat. Gas	✓			✓		✓	45
2. Coal	✓				✓	✓	55
3. Oil	✓						5
4. Hydro		✓	✓	✓	✓	✓	95
5. Nucl.	✓	✓			✓	✓	60
6. Geo-thermal	✓	✓	✓	✓	✓	✓	100
7. Alchl	✓		✓	✓	✓	✓	95
8. Wood	✓		✓	✓	✓	✓	95
9. Wind		✓	✓	✓	✓	✓	95
10. Solar	✓	✓	✓	✓	✓	✓	100
11. Waste	✓		✓	✓	✓	✓	95
12.							
13.							
14.							

Student Worksheet

ENERGY USES AND NEEDS

Source:

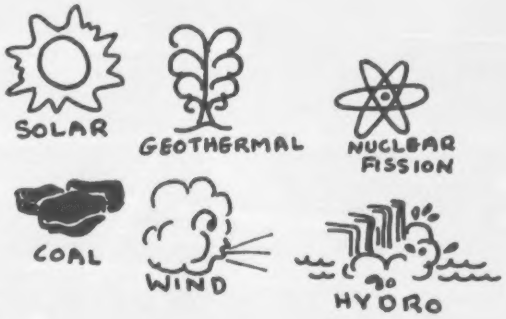
Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

DEMAND
SUPPLY

"The future is not what it used to be." Especially our energy future. Arkansas shares the national challenge of adjusting to the widening gap between energy supply and demand. Adjusting to the new realities of energy scarcity and high prices after an era of abundant and cheap energy has proved trying for Arkansans, as for all Americans.

OIL
NATURAL GAS

Like the nation, Arkansas relies most on scarce energy resources and least on abundant energy resources. This is the crux of the so-called "energy crisis." The problem is not that we are running out of energy, but rather that we are running out of the forms of energy -- oil and natural gas -- that we have come to depend upon so heavily.



The energy dilemma that now faces Arkansas and the United States, which is expected to intensify during the 1980's, results from the divergence between an increasing energy demand and a decreasing domestic production of oil and natural gas. To solve its long term energy problem, Arkansas, like the nation, must undergo a major transition from dependence on oil and natural gas to dependence on other energy resources.

There are plenty of other energy resources to turn to when the oil and natural gas run out -- coal, nuclear fission, geothermal, solar, and others. Some are technically and economically more feasible than others. Some are more environmentally attractive than others.

The energy transition we presently face, unlike previous transitions, is being forced upon us by scarcity. After the next decade or two our hope for energy to sustain a stable society and a healthy economy rests, in large measure, on the development of renewable and essentially inexhaustible sources of energy. A long time is needed to bring a new energy source into a large- scale role in the society. Past experience has shown that it requires "lead time" to develop an energy technology and for it to make a meaningful contribution. Previous large- magnitude, American energy transitions required about 20 to 30 years.

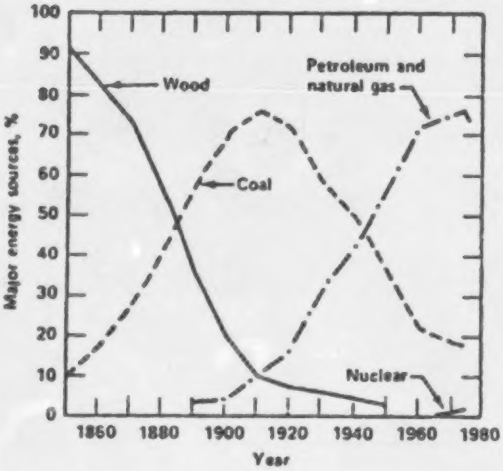
Therefore, it is imperative that we start turning now to alternative energy sources. The longer we wait, the more difficult the changeover will be.

With supplies of oil and natural gas declining, and a need to reduce reliance on foreign oil, Arkansas, like the rest of the nation, is facing the

Student Worksheet

ENERGY USES AND NEEDS

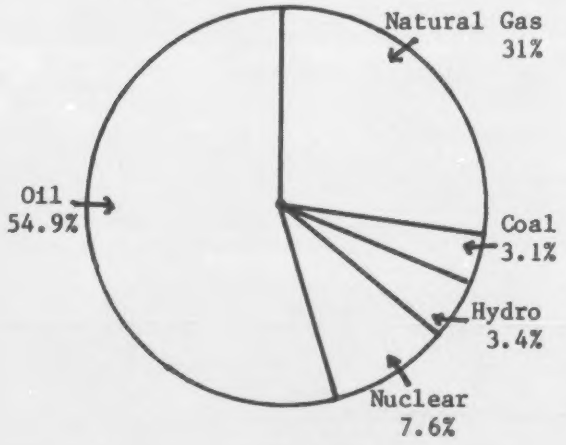
HISTORICAL U.S.
ENERGY CONSUMPTION PATTERNS



challenge of providing domestic energy sufficient to meet the increasing demand of a growing and healthy economy. Arkansas' choices range from strenuous efforts to reduce energy consumption to development and utilization of all alternative energy sources.

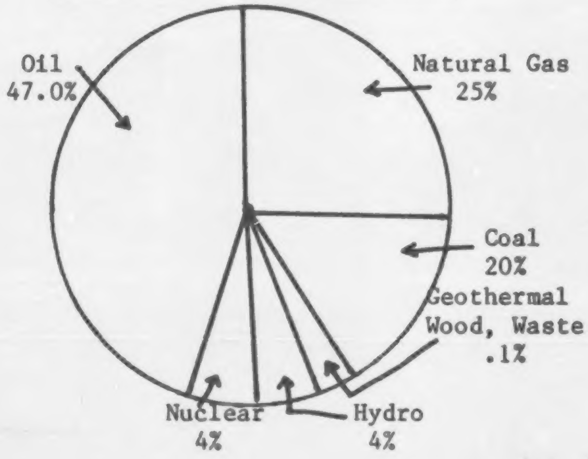
Oil and natural gas will continue to play a major, but decreasing role in the Arkansas energy mix. Increasingly, Arkansans, like all Americans, will need to turn to alternative energy production, along with a major conservation effort. Arkansas is fortunate in having many alternative sources of energy to develop and use.

Arkansas Energy Sources



1978

United States Energy Sources



1979

Source: Arkansas Energy Office

Student Worksheet

ENERGY USES AND NEEDS

Answer the following questions:

1. Explain the following statement. "The problem facing Arkansas and the United States in not that we are running out of energy."

2. Label as increasing or decreasing:
   _____Domestic production of oil and natural gas
   _____Energy demand
   _____Use of imported petroleum
   _____Need for renewable energy sources
   _____Oil and natural gas resources
   _____Conservation efforts

3. Name some alternative energy sources that may replace oil and natural gas.

4. Today's energy transition is being forced on us by _____________________. In the past energy transitions were usually a result of _______________ ______________________________.

5. Why is Arkansas more fortunate than many states during this energy crisis?

6. One of the easiest and cheapest alternative energy methods available to everyone is _________________________.

7. What is the main source of energy for Arkansas? _____________________. For the United States? ______________________________.

8. What renewable energy resources are used in Arkansas?

   In the United States?

9. Arkansas and the United States both rely most on _____________________ energy sources, and lest on ____________________ energy sources.

10. Which Arkansas energy sources should be encouraged?

    Which United States energy sources?

    Why?

Student Worksheet

ENERGY USES AND NEEDS
ANSWER SHEET

1. We are running out of energy types that we depend on the most.

2. Decreasing
   Increasing (but slowing down)
   Increasing
   Increasing
   Decreasing
   Increasing

3. Coal, nuclear fission and fusion, gethermal, direct solar, hydroelectric, biomass, wind.

4. Scarcity
   Convenience

5. Arkansas has many alternative energy sources to develop and use.

6. Conservation

7. Oil
   Oil

8. Hydroelectric, biomass, direct solar
   Hydroelectric, geothermal, biomass, direct solar, wind

9. Nonrenewable; scarce
   Renewable; plentiful

10. Answers vary

Student Worksheet

ENERGY SOURCES FOR THE FUTURE

ENERGY SOURCE	PROCESS	PRODUCT
RENEWABLE RESOURCES:		
Geothermal	Drill holes in earth over hot spots/earth shelter	Hot water and/or electricity
Hydroelectric	Falling water turns generator	Electricity
Biomass	Gasification & liquefication, burning, fermentation	Methane, heat, gasoline, petroleum
Wind	Windmill turns generator	Electricity or mechanical work
Solar collection, absorption, concentration	Concentrate sunlight to heat water or air	Heat for water, homes, buildings
Solar cells (photovoltaics)	Use solar cell to change solar to electric energy	Electricity
Conservation	Reduce use and increase efficiency	More energy for later
NONRENEWABLE RESOURCES:		
Coal oil	Heat coal under pressure	Oil & gasoline
Coal gas	Burn coal	Gas
Oil shale	Melt rock	Oil & Gas
Nuclear fission	Split uranium atom	Electricity
Fast breeder fission	Use fission waste to produce own fuel	Electricity
Nuclear Fusion	Fuse atoms together - release energy	Electricity
Magnethohydrodyhnamics (MHD)	Burn fossil fuels; magnetic field generates electricity	Electricity
Fuel cells	Chemical process	Electricity
Heat pump	Pump heat out in summer and in during winter	Space heating or cooling
Hydrogen	Use electricity to form hydrogen from water	Hydrogen gas

(Place this page together with page 12.15)

Student Worksheet

ENERGY SOURCES FOR THE FUTURE
(Continued)

ADVANTAGES	DISADVANTAGES	CURRENT U.S. STATUS
RENEWABLE RESOURCES:		
Already hot; abundant	Might cause earthquakes; not everywhere; air, noise pollution	Used in some locales
Low operating cost; no air pollution	Floods land; stops free-flow of streams	Common in some areas, including Arkansas
Abundant; not storage problem	Widely dispersed; low net energy yield if transported far	Heat production; gasohol
Abundant; independent source	Variable; visual and noise pollution; storage	Used in some locales
Abundant independent source	Clouds and night prevent use	Becoming more popular but use not widespread
Abundant independent source	Clouds and night prevent use; materials expensive; storage	Looking for ways to decrease cost; used by spacecraft
Saves money and environment	Difficult to change people's attitudes and behavior	Govt., industry, schools, individual use
NONRENEWABLE RESOURCES:		
Car use	Air and land pollution; energy to produce	No production facilities
Car use	Air and land pollution energy to produce	One plant in operation
Other petroproducts	Air, water, land pollution; waste; water need; reclamation	Limited production in Western U.S.
1 pound uranium = 50 million pounds coal	Wastes last thousands of years; finite uranium; reactor and radiation danger.	Over 60 plants operating
Makes own fuel	Plutonium dangerous; chain reaction; tempting to terrorists	1 non-operating plant
Minimal pollution	Radiation; need temperature of 100 million degrees	First plant after Year 2000
No moving parts; heat waste	Need super magnets	In lab tests
No moving parts; little heat waste	Use scarce metals	Used by astronauts on moon; soon by power companies
Uses environmental heat	Expensive; some problems with break downs	Can be purchased
Use like natural gas; little pollution	Energy needed to get it; difficult to store; water scarce	Used in experimental cars and buses

(Place this page together with page 12.14)

Student Worksheet

ENERGY RESEARCH

You are to read several articles in books, newspapers, magazines, etc. regarding your assigned energy resource. If a television special on your topic occurs during this study, you might use data from the program. Your assignment is to gather as much data on the advantages and disadvantages of your assigned energy resource as possible.

You are to record the advantages and disadvantages on this worksheet. With each entry of an advantage or disadvantage you should also note the source of the information and the date of the publication. After completion of this worksheet, you will present your findings to the class.

Advantages	Disadvantages

Student Worksheet

ENERGY BUDGET

1. List the energy sources researched and reported on by the class groups down the left hand side of the paper.
2. Rank these energy sources from 1 - 10 (1 being first and 10 being last) according to the order in which you feel they should be developed.
3. Assign each energy source the part of the total energy budget you feel it should receive.
4. Be prepared to explain your budget to the class.

ENERGY SOURCE	RANK	BUDGET

Total - $31 billion
for 1981

LESSON #13

CATEGORY: Conservation

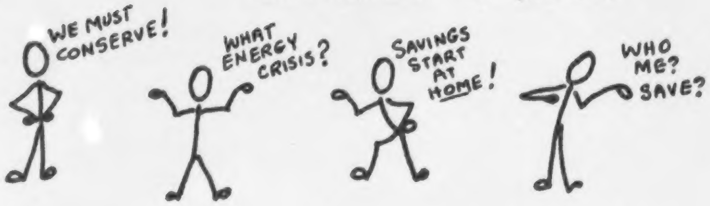
ENERGY TYPE: All

TITLE: What do we do Now?

GRADE LEVEL: 7-10

INFUSE WITH SUBJECT AREA:
Social Studies
Science

TIME NEEDED: Two periods


WE MUST CONSERVE!
WHAT ENERGY CRISIS?
SAVINGS START AT HOME!
WHO ME? SAVE?

MATERIALS:
None

OBJECTIVES:

1. The students will express their opinions on the energy crisis.
2. The students will become familiar with the production and consumption of energy in Arkansas.
3. The students will become familiar with energy consumption in Arkansas by sector of use.
4. The students will develop recommendations designed to help Arkansans cope with the energy crisis.
5. The students will consider future energy options as developed by the United States Department of Energy
6. The students will re-examine their previously expressed energy opinions and state attitudinal changes, if any.

TASK ANALYSIS:

The students should be able to read and interpret graphs.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 13.8 - 13.16.
   Read Teacher Background Information 13.4 - 13.7)

2. Steps in Lesson
   Objective #1: The students will express their opinions on the energy crisis.

   a. Have the students take the Energy Attitude Survey on Student Worksheets 13.8 - 13.9. Do not discuss the results immediately. Collect the surveys and save for later reference.

   Objective #2: The students will become familiar with the production and consumption of energy in Arkansas.

   a. Hand out Student Worksheets 13.10 - 13.13. Have the students answer the questions on each chart individually, then discuss the answers in class. The answers to these Worksheets are found on 13.13a.

   Objective #3: The students will become familiar with energy consumption in Arkansas by sector of use.

a. Hand out Student Worksheets 13.14 - 13.15. Have the students answer the questions individually, then discuss the answers in class. The answers to both worksheets are found on 13.15a.

Objective #4: The students will develop recommendations designed to help Arkansans cope with the energy crisis.

a. Tell the students that they comprise a committee set up by the state Legislature. The purpose of this committee is to develop recommendations that Arkansas should follow to deal with the energy crisis, so that there will be provision made, not only for today's energy needs, but for those of future generations. Do this activity in small groups, then combine the recommendations to make a master list. You may wish to add to the master list the recommendations found in the Teacher Background Information; or give a copy of the recommendations to the students and let them make a comparison of the two lists.

Objective #5: The students will consider future energy options as developed by the United States Department of Energy.

a. Hand out (or show on overhead) Student Worksheet 13.16. Discuss the impacts of this plan on the future of the United States. Ask the students to discuss such ideas as:
   - -Do you agree with the priority assignments in this plan? Why or why not
   - -How do you think the United States is progressing, so far, toward fulfilling this plan?
   - -Would this plan work for Arkansas? Why or why not?
   - -How does this plan compare with the master list of recommendations you drew up for Arkansas? Which do you feel is the better plan? Why?

Objective #6: The students will re-examine their previously expressed energy opinions and state attitudinal changes, if any.

a. Hand out a second copy of Student Worksheets 13.8 - 13.9 and have the students fill out the Energy Attitude Survey for the second time.

b. Compare the pre- and post-survey results. Discuss any changes in attitude or knowledge that the students feel they have made.

3. Evaluation

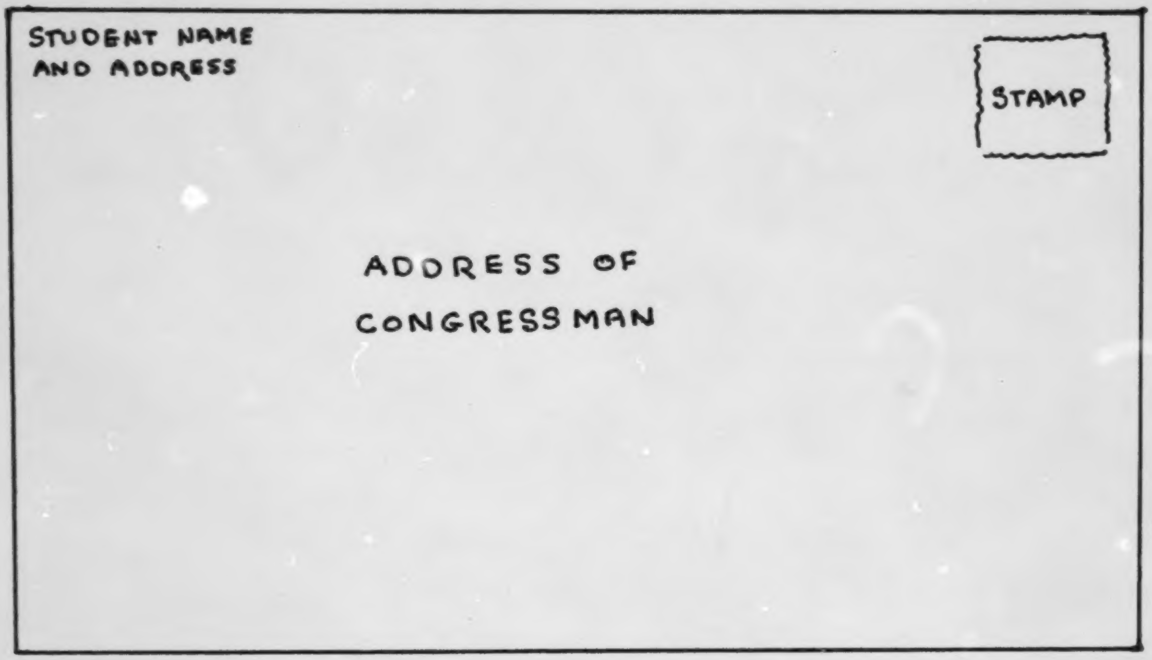
Use the pre- and post-Energy Attitude Survey as an indication of changes in student attitude.
Check student answers to Worksheet questions for understanding of material.
Use oral evaluation during the development of Arkansas energy recommendations to assess student grasp of the energy situation.

4. Follow-Up Activities

Have the students administer the Energy Attitude Survey to adults in the community, then compare the results to the results of their own survey. Discuss differences of opinion in the two age groups; ask students to give reasons for these differences.

Make lists of ways conservation could be practiced in the various energy use sectors in Arkansas.

Have the students write their congressmen expressing their feelings about the energy crisis, and enclosing a list of the recommendations drawn up by the class.


STUDENT NAME
AND ADDRESS
STAMP
ADDRESS OF
CONGRESSMAN

TEACHER BACKGROUND INFORMATION

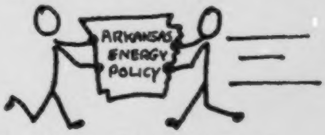
Source:

Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

Developing new energy sources and conserving energy are requisite to any solution to our current energy woes, but these will not likely succeed without an overall guiding energy policy. At both the national and state levels, the rhetoric that public officials lavish upon the energy crisis is, for the most part, not being translated into action. The limited and fragmented energy policy that has been formulated is framed as though it were addressing a problem that our grandchildren will inherit. In coming to grips with the energy crisis in Arkansas and the nation, we need less reaction and more action.

The following proposed recommendations, if taken to heart by Arkansas citizens and policy-makers, and carried out, will go a long way toward a resolution of our energy problems and, at the same time, minimize harm to our environment. These recommendations, which are all interrelated, call for action. They are presented here in brief fashion; it is recognized that their implementation will be a complex, enormous and expensive undertaking. But the complexity, enormity and expense of attempting to address the problems resulting from not acting on these recommendations will likely be even greater. These recommendations certainly do not exhaust the possible efforts that can be taken, but rather, represent one set of actions that can likely move Arkansas in the direction of a more promising energy future.

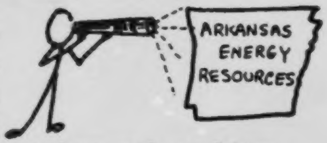
1. A comprehensive Arkansas energy policy should be developed and carried out.



The energy problems of the United States are varied. Arkansas, like every other state, has its own array of local resources and problems, which are too numerous and complex to be handled by the federal bureaucracy. The Arkansas state government should develop and carry out a comprehensive Arkansas energy policy, using the intellectual, technical and managerial talent available within its own borders, as well as outside the state. Events of the past decade should warn that complete dependence on Washington is unwarranted. Arkansas and the other states should not wait for federal grants before tackling energy problems; they can be leaders rather than followers by establishing and funding their own energy programs. There could be far broader citizen participation, and Arkansans could come to know what they already instinctively feel -- that in the long run they must rely on their own wisdom and effort.

A comprehensive Arkansas energy policy should place emphasis on a massive energy conservation program to reduce energy waste, decrease the adverse environmental impact of energy use, reduce dependence on foreign oil, save money, decrease the total and per capita use of energy, and buy time to develop and phase in a mix of other energy alternatives before oil and natural gas are depleted. More money needs to be devoted to developing improved methods of conservation.

2. A comprehensive survey of Arkansas' energy resources should be undertaken



A long-range Arkansas energy policy should be built upon a solid informational foundation. The more information available regarding Arkansas' energy resources, material and human, the more effective will be the planning and decision-making. Resource base surveys are needed to determine the quantity and quality of Arkansas' energy resources and reserves, including oil recoverable by enhanced recovery methods, natural gas, lignite, geothermal, small dams that can be tapped for hydropower, forests, agricultural crop residues, and municipal wastes. Solar radiation data are needed for different locations around the state, perhaps in each county, for designing solar systems. Similarly, wind data (speed and variability) are needed to know whether a wind turbine would be profitable in a particular location.

A comprehensive survey of human resources in Arkansas should also be performed. All professionals -- technicians, managers, academicians and others -- in the energy field should be identified for inclusion in an "expertise pool." This would facilitate access to energy talent in the future.

In additiona to the resources inventories, a thorough assessment of the environmental, economic and social impacts of all alternative energy resources development and use should be undertaken. This information would increase the chances that the best possible decisions for Arkansas will be made.

3. Environmental safeguards should not be relaxed due to demands for increased energy production.

MORE ENERGY!
NO!
ARKANSAS ENVIRONMENT
GUARD STATION

The fact must be faced that for the foreseeable future clean energy is a mirage. All sources of energy cause one kind of environmental problem or another. Yet society need not be seduced into abandoning environmental protection goals for this reason. The time has come to weigh the choices available and chart the most direct possible course toward cleaner energy. In developing this strategy we must be certain that we control the most serious problems and not dissipate our resources by tackling all problems indiscriminately. Even though each energy source has its environmental costs, we can be selective in choosing areas and techniques to minimize adverse environmental impacts.

Fuel use harms the environment more than any other human activity: it heats the atmosphere, generates pollutants, scars the landscape, and creates dangerous radioactive by-products. We can justify some of these energy costs for necessary pruposes. But to increasing numbers of people, the costs of continued energy growth now seem to outweigh perceptible benefits. The search for new energy systems involves more than just the need to provide an alternative to OPEC oil. The primary need is to find the kind of energy mix that will run an industrial society without imposing ghastly penalties on living things.

4. **Arkansas should pursue the environmentally and socially-responsible development of all energy resources.**

?
HARD PATH
SOFT PATH

There is vigorous debate over whether the intermediate and long-term energy strategy for Arkansas, as well as the nation, should follow a "hard path" or a "soft path." Following the hard path (or conventional route), major emphasis would be placed on coal and nuclear. The soft path would emphasize energy conservation and all forms of solar energy.

Even though the soft path is the preferred path, because it is less injurious to the environment, Arkansas should proceed with the development of all alternative energy resources, hard and soft, if such development is environmentally and socially responsible. We are presently not in a position to "close the door" on any energy option that represents a potentially significant contribution to our future energy supply, unless the further development of that energy option is deemed environmentally and socially irresponsible by Arkansans. The determination of irresponsibility needs to be provided for as a part of a comprehensive Arkansas energy policy.

Proceeding with the development of all alternative energy sources will increase the energy mix of Arkansas and thus decrease reliance on any single or few energy resources. A mix of energy sources will lessen vulnerability during energy shortfalls, especially during the 1980's when widespread solar cannot yet be a reality.

5. **The federal and state governments should proceed with haste to find a solution to the nuclear wastes problem.**

RADIATION WASTES

There needs to be a national program of radioactive waste disposal and management, with a clear dilineation of federal, state, and private responsibilities. The locations of nuclear waste disposal should be determined with full public participation. The states should have an active role in this decision. There needs to be a sense of urgency and priority on the part of state and federal government to address this growing problem. As long as this problem remains unresolved, the public's health and safety are threatened.

6. **Arkansas should pursue energy conservation more vigorously.**

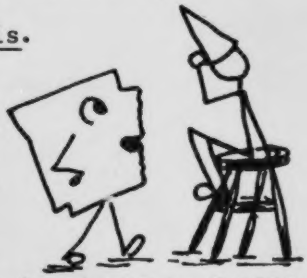
HELP SAVE
FOR A GOOD ARKANSAS ENERGY FUTURE

Arkansans should, at the same time they are developing alternative energy sources, strive to curtail wasteful consumption of all energy resources. Energy conservation will allow us to avoid objectionable energy sources while the search for safer, sustainable sources continues.

A strong state and national conservation program will come about only if demanded by an aroused and informed citizenry.

Most importantly, the level of future energy use must be viewed as a matter of choice. Nothing is binding about the upward-trending curves that many energy studies use to project future demand. Often, such curves tend to become self-fulfilling prophecies. Every energy source has costs and risks, and these will grow as energy use levels rise. Our cheapest and best option today is to harness the major portion of our energy budget that we waste. A vigorous program of energy conservation should become an Arkansas and national imperative.

7. Energy education should be taught in the Arkansas shcools.



"DON'T BE AN ENERGY DUMMY!"

There is a need to bring into focus, in the Arkansas education system, a broad spectrum of information regarding energy resources, conservation, alternatives to current technologies, environmental and economic implications of the use of energy, and energy careers. Energy-related subject matter is a means of increasing the capability of the public to make informed judgements regarding present and future energy resource development, use, conservation and careers.

The Arkansas schools have an urgent responsibility to include energy-related topics at all levels and in all appropriate disciplines, preferable as part of an integrated, comprehesive energy education program. Arkansans need an understanding of the energy "facts of life" and an awareness of the severity of the energy-related problems. Only then can they intelligently decide questions of energy production and consumption in a way that is consistent with the requirements of the new energy era.

Student Worksheet

ENERGY ATTITUDE SURVEY

Express your opinion by putting "yes" or "no" in the blanks to the left of the questions.

______1. Do you believe there is an energy crisis?

______2. Does the evergy crisis affect you?

______3. Do you believe the public has been given a realistic picture of the energy situation facing Arkansas?

______4. Do you believe there is an energy crisis that has been contrived by major oil companies of the United States?

______5. Do you believe most Arkansans are energy "wasters"?

______6. Do you believe most Arkansans are energy "savers"?

______7. Do you believe it is the responsibility of every Arkansas citizen to conserve energy voluntarily?

______8. Do you believe government controls should be imposed to enforce energy conservation?

______9. Would you conserve energy to save money?

_____10. Do you feel it would be necessary to reduce your standard of living if you practiced conservation?

_____11. Do you feel technology will "bail us out" of the energy shortage?

_____12. Do you believe that an individual can make a significant impact on Arkansas energy conservation?

_____13. Who, in your opinion, is most affected by today's energy crisis? Rank 1 (highest) to 10 (lowest).

_____oil companies
_____industry
_____towns and cities
_____small business
_____low-income people

_____politicians
_____high-income people
_____mining companies
_____your family
_____electric utilities

Student Worksheet

ENERGY ATTITUDE SURVEY
(Continued)

14. Just how imporant do you believe the energy crisis is? Rank the following problems from 1 (highest) to 10 (lowest):

_____moral decay
_____environmental pollution
_____threat of war
_____drug abuse
_____racial tension
_____monetary inflation
_____unemployment
_____energy crisis
_____crime
_____big business

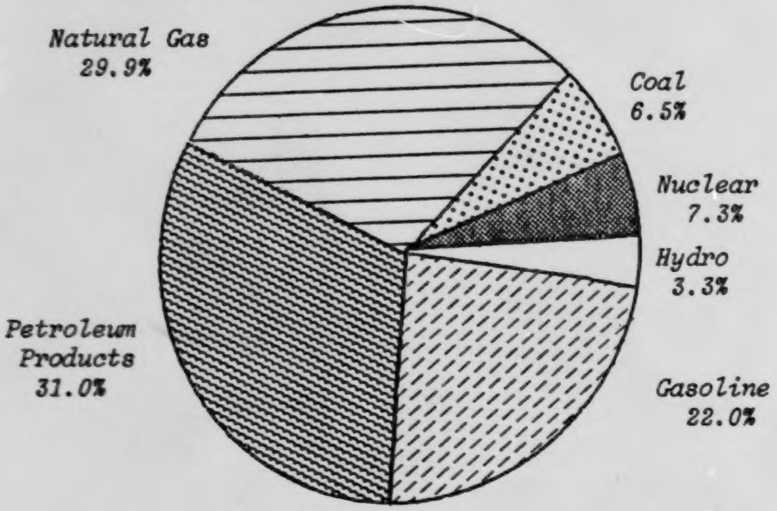
15. Rank the following in the order by which you believe they should receive government funding from 1 (first funding) to 5 (last funding):

_____Development of improved methods of conservation
_____Development of domestic fossil fuel resources (coal, oil and natural gas)
_____Development of synthetic fuels
_____Importation of fossil fuels (oil and natural gas) from foreign nations.
_____Development of alternative energy sources (direct solar, geothermal, hydro, wind) other than fossil fuels.

? ?
WHAT DO I REALLY THINK ABOUT THE ENERGY CRISIS ?

Student Worksheet

ARKANSAS GROSS ENERGY CONSUMPTION
BY FUEL
1978



Total Gross Energy Consumption
761.22 Trillion BTU's

Source: Arkansas Energy Office

Answer the following questions about the graph:

1. Over 80 percent of Arkansas' energy comes from what type of fuels?

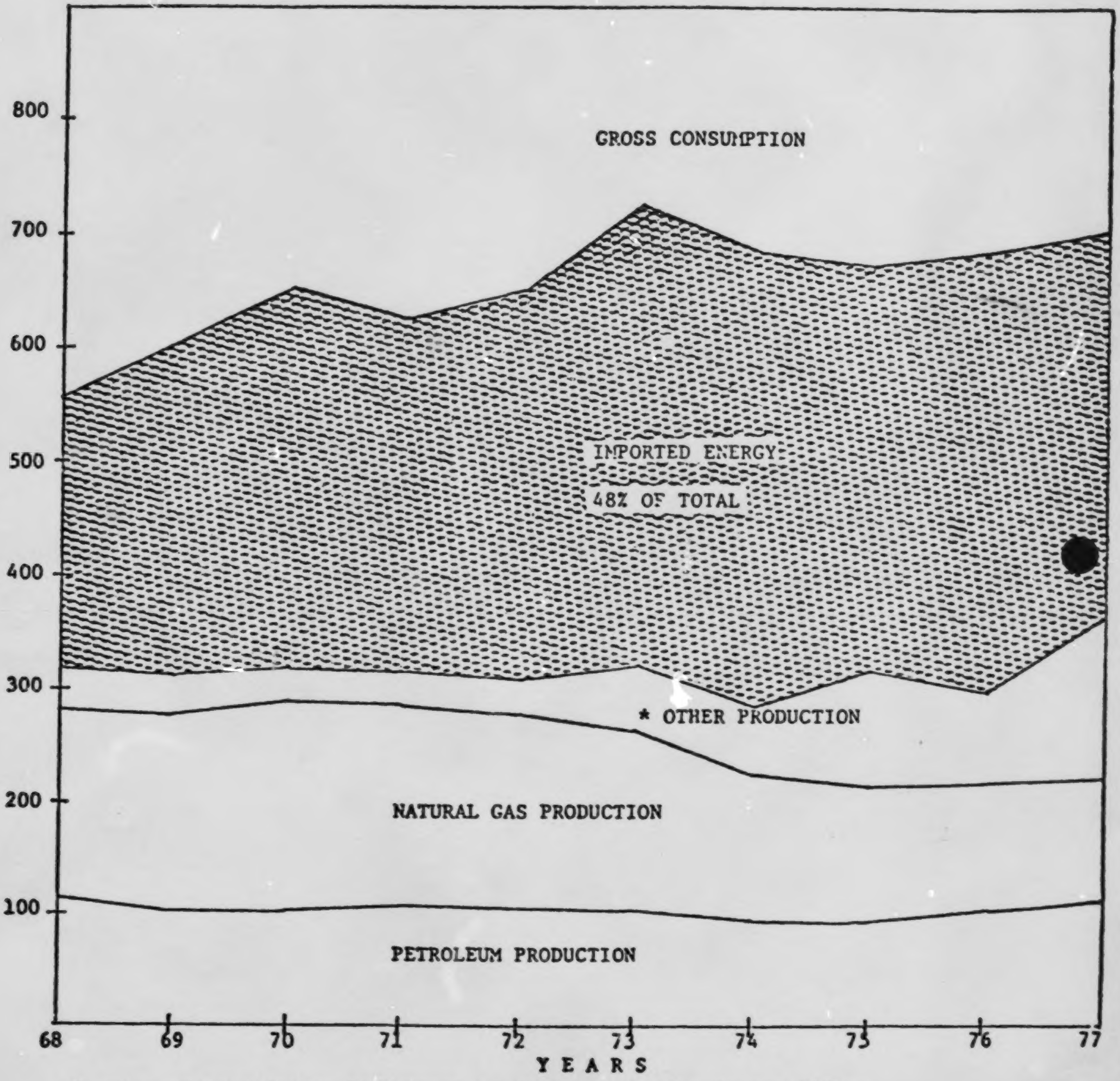
2. Why is this a dangerous imbalance of energy types?

3. What adantage do other energy sources have over fossil fuels?

4. List some other energy sources that Arkansas would be wise to develop.

Student Worksheet

PRODUCTION AND CONSUMPTION OF
ENERGY IN ARKANSAS



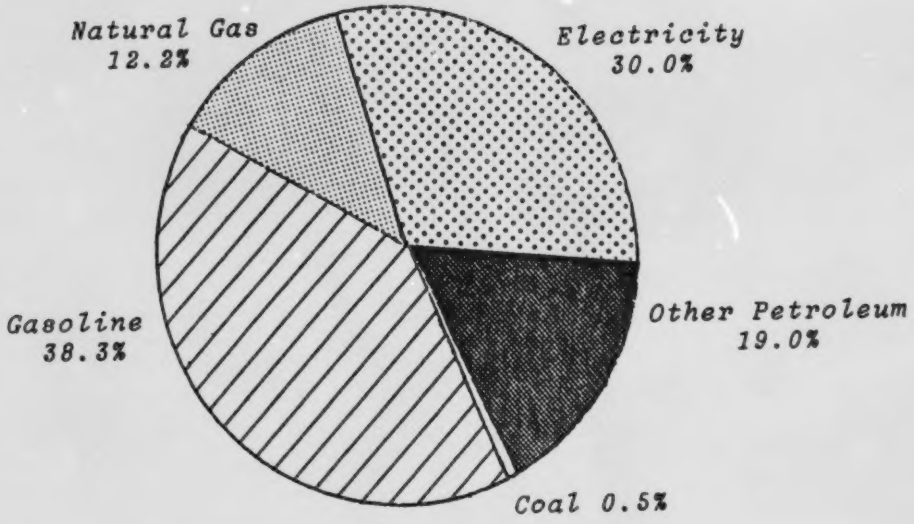
Source: United States Department of Energy; Arkansas Energy Office.
*Other production is the sum of coal production and hydro and nuclear generated electricity.

Answer the following questions about the graph:

1. How much of Arkansas' energy is imported?
2. Why are coal, hydro and nuclear lumped together under "other production."
3. What might occur in Arkansas if United States oil imports were suddenly cut by 75 percent?

Student Worksheet

ARKANSAS RETAIL ENERGY DOLLAR
1978



Estimated total retail cost of energy in 1978:
2.3 billion dollars

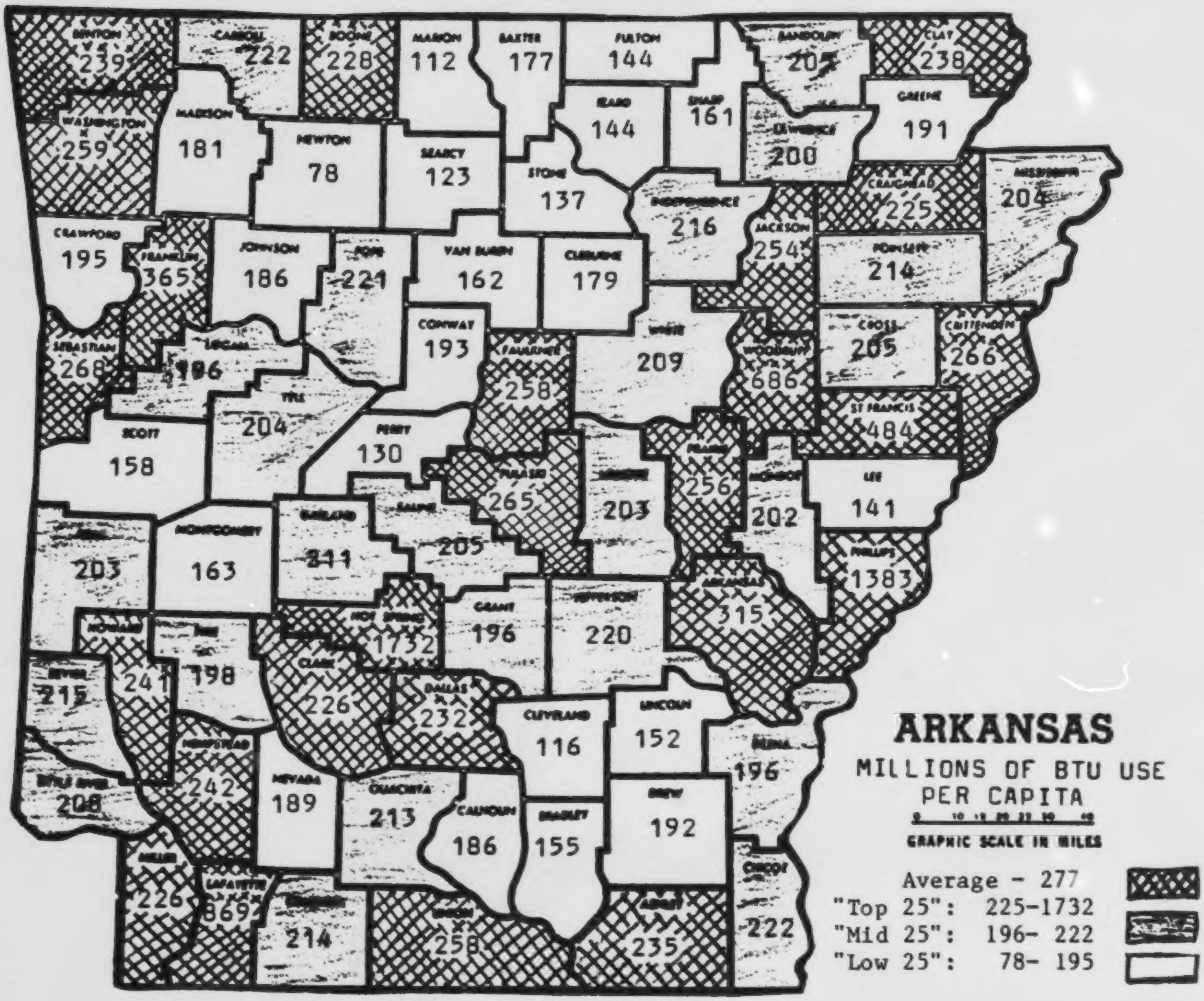
Source: Arkansas Energy Office

Answer the following questions about the graph:

1. Arkansas's single largest energy expenditure in 1978 was for __________?
2. What are some means by which this largest user could be reduced?

Student Worksheet

ARKANSAS ENERGY USE
BY COUNTY
1976


239
222
228
112
177
144
205
238
259
181
78
123
144
161
200
191
137
204
225
216
195
365
186
221
162
179
254
214
268
196
193
209
205
266
258
686
204
484
158
130
265
203
256
202
141
203
163
211
205
1383
196
220
315
215
241
198
1732
226
232
116
152
196
208
242
189
213
186
155
192
226
369
214
258
235
222
ARKANSAS
MILLIONS OF BTU USE
PER CAPITA
GRAPHIC SCALE IN MILES
Average - 277
"Top 25": 225-1732
"Mid 25": 196- 222
"Low 25": 78- 195

Source: Brookhaven National Laboratory

Answer the following questions about the map:

1. What is the average amount of energy used per capita by the counties in Arkansas.
2. Which Arkansas county was the highest per capita user of energy in 1976? The lowest?
3. Energy use in Arkansas' counties ranges from a low 78 million BTU's to a high 1732 BTU's. Account for this wide range.
4. Where does your county rank in Arkansas energy use? Do you agree with this placement? Why or why not?
5. Should all Arkansas counties receive the same energy allocation? Why or why not?

Student Worksheet

ANSWER SHEET

Worksheet 13.10

1. Fossil fuels
2. Fossil fuels are running out; we should be leaning more toward the renewable resources.
3. They are renewable.
4. Direct solar, waste, hydroelectric, wind, etc.

Worksheet 13.11

1. 48 percent
2. They are all produced in small amounts as compared to petroleum and natural gas.
3. There would be severe shortages in all sectors.

Worksheet 13.12

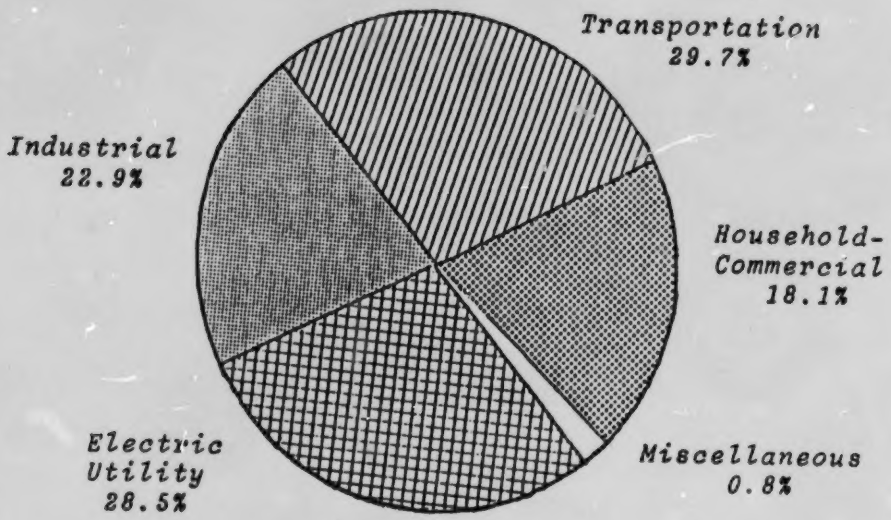
1. Gasoline
2. Conservation, mass transit, more efficient vehicles, etc.

Worksheet 13.13

1. 277 million BTU
2. Hot Springs, Newton
3. Population, industry, topography, etc.
4. Answer varies with county
5. Answer varies with students, but they should be reminded that different counties have different needs. Use varies with population, industry, topography, tourism, etc.

Student Worksheet

ARKANSAS GROSS* ENERGY CONSUMPTION
By Sector
1978



Total Gross Consumption: 761.22 Trillion BTU's
Source: Arkansas Energy Office
*Total gross energy consumption includes all energy inputs into the economy coal, petroleum, natural gas and the electricity generated by hydroelectric and nuclear powerplants. Gross consumption includes conversion losses by the electric power sector.

Answer the following questions about the graph:

1. _______ is the biggest energy user in Arkansas.

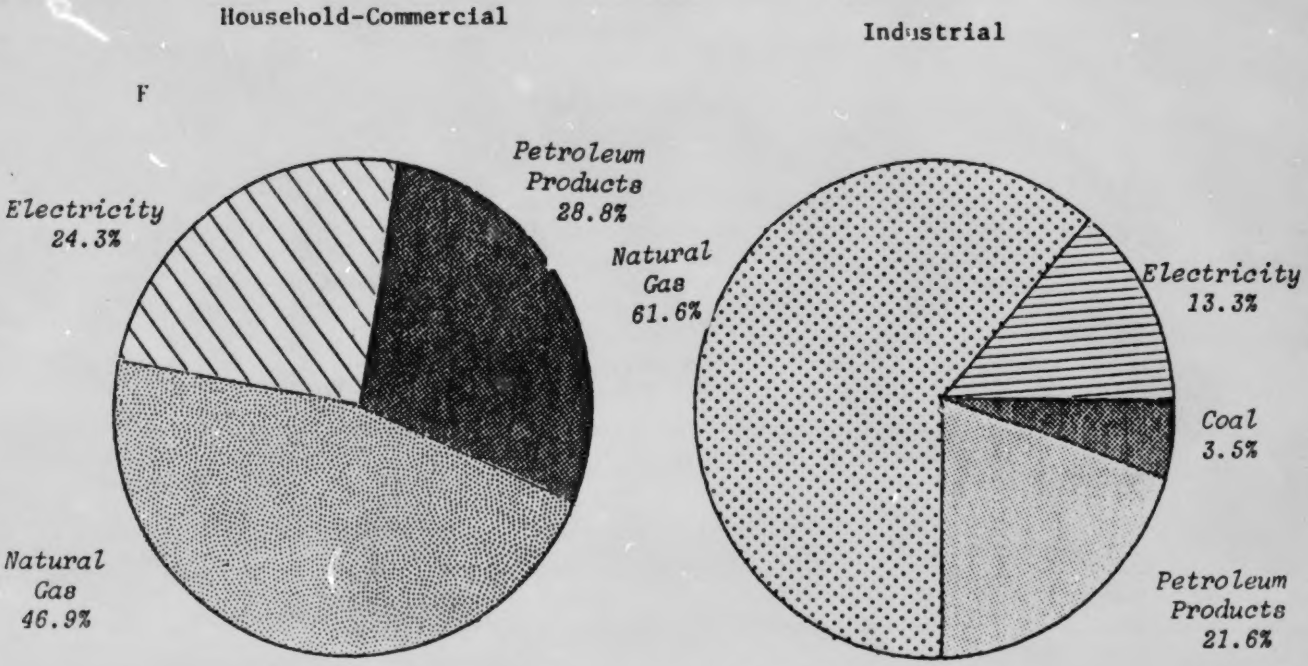
2. Which energy use sector(s) do you, personally, have effects on?

3. What do you think is the main fuel for the generation of energy in each sector?
   Transportation:
   Electricity:
   Industry:
   Home and commerical:

205

Student Worksheet

ARKANSAS ENERGY CONSUMPTION
BY SECTOR
1978



Total Net Energy Consumption
181.69 Trillion BTU's

Total Net Energy Consumption:
200.90 Trillion BTU's

Source: Arkansas Energy Office

Answer the following questions about the graph:

1. ________ is the energy source most used by homes, commercial establishments and inudstry.

2. What industrial energy source is likely to increase in usage during the near future?
   Why?

Student Worksheet

ANSWER SHEET

Worksheet 13.14

1. Transportation
2. All of them
3. Transportation: oil

   Electricity: oil (this is true for 1978-79), it may change for subsequent years

   Industry: natural gas

   Home and commerical: natural gas

Worksheet 13.15

1. Natural gas
2. Coal

   There is more coal than petroleum and natural gas; many believe coal will be faster to implement than some of the alternatives such as direct solar.

Student Worksheet

POSSIBLE FUTURE ENERGY OPTIONS FOR THE UNITED STATES

An overview of the United States energy future as envisioned by the United States Department of Energy in 1976 is shown below.

IMPACT OF FUTURE ENERGY OPTIONS

Priority*	**Near-term: 1976 to 1985**
Highest	Enhanced recovery of oil and natural gas Direct use of coal by utilities and other industries Waste materials to energy Nuclear converter reactors Transportation efficiency Industrial energy efficiency Conservation in buildings
	Midterm: 1985-2000
Highest	Gaseous and liquid fuels from coal Oil shale
Other	Geothermal Solar heating and cooling Waste heat utilization Electric conversion efficiency Energy storage
	Long-term: 2000+
Highest	Solar electric Breeder reactors Fusion
Other	Fuels from biomass Hydrogen in energy systems Electric power transmission and distribution Electric transport

*Under the Plan technologies with highest priority would be pursued vigorously with a high level of support. Other technologies would be given support that is more measured but sufficient to permit response to favorable developments.

LESSON #14

CATEGORY: Uses

ENERGY TYPE: Electricity

TITLE: Electricity in Arkansas

GRADE LEVEL: 7-9

INFUSE WITH SUBJECT AREA:
Science
Social Studies
Math

TIME NEEDED: One period

MATERIALS:
None

OBJECTIVE:

The students will gain a general understanding of the production of electricity in Arkansas.

TASK ANALYSIS:

The students should be able to read material and answer questions from that material; be able to read maps; and be able to do basic math computations.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 14.3 - 14.5

2. Steps in Lesson
   Objective: The students will gain a general understanding of the production of electricity in Arkansas.

   a. Hand out Student Worksheets 14.3 - 14.4. Have the students read and discuss the material; answer the questions independently; then discuss the answers in class.
   b. Hand out Student Worksheet 14.5. Have the students answer the questions independently, then discuss the answers in class.
   c. Propose the following situation to the students:
      Your home is in a small community located on the Arkansas River. An electric utility company proposes the construction of a new coal-fired generating plant in your community. It will be located on the river so the warm water from the plant (condensed steam) can be released into the river. The plant will be large enough to supply 1,000 megawatts of electrical power.
      Discuss the following questions:
      -What advantages will the siting of this generating plant offer? (Economy, jobs, etc.).
      -What disadvantages will result? (Pollution, transmission lines, supply vehicles through town, etc.).
      -Would you prefer an occasional blackout or brownout to having a new power plant built in your community? Why or why not?

-Investigate whether people in communities which encourage siting of utility plants in their area get lower rates for electricity. (No).
Should they?

3. Evaluation

Check answers to student worksheets

Oral evaluation during class discussions.

4. Follow-Up Activities

Trace the historical influence of electricity on: industry, society, education, power distribution, recreation and life-style in Arkansas and/or the United States.

Invent a form of power to replace electricity.

Take a field trip to an electrical generating plant in your area or invite a speaker from this plant to the class.

Student Worksheet

ARKANSAS AND ELECTRICITY

Sources:

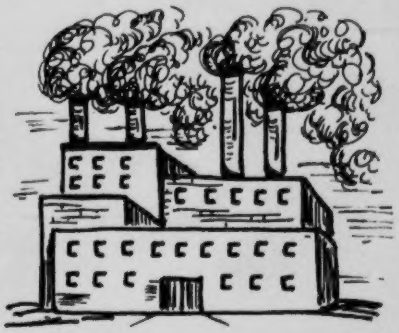
Paul L. Butt. Arkansas and Energy: A Look at the Alternatives.
Arkansas Ecology Center: Little Rock. 1979.

Arkansas Energy Office. Little Rock.

Electricity is a secondary energy source -- that is, it is produced through the use of some other energy source. The electric utilities in Arkansas represent both major energy users of primary energy resources and major suppliers of electrical energy to end-users. About 10 percent of the total primary energy consumed in Arkansas is used in generating electricity which, in turn, supplies about 24 percent of final end-use consumption.

In generating electricity, the fuel mix used by the Arkansas utilities is considerably atypical in comparison with the national average. The Arkansas energy inputs for electrical generation are considerably above national averages for oil and nuclear, and substantially below the national average for coal. The Arkansas mix will more closely reflect the nation's mix later in the 1980's as coal and lignite-fueled power plants begin operating.

Electric power plants have been one of the major sources of air pollution. They contribute about 25 percent of particulates (soot), 25 percent of nitrogen oxides, and 55 percent of sulfur oxides emissions. In the past 20 years the size of electric power plants have doubled and redoubled to achieve economies of scale. As the plants have increased in size they have been located in rural areas because safety and pollution considerations force their removal from uban sites.



But moving to the countryside has not solved the environmental problems. In any location a huge power plant overwhelms the surrounding environment. An electric power plant requires a large tract of land -- more than 1,000 acres in the case of a coal-fueled plant -- because of the need for coal storage and for land to receive the ash and other solid wastes which remain after the coal is burned.

Electrical transmission is unfortunately a very expensive method of energy transmission. Electricity is transported from generating stations to major consumption centers on transmission lines which, in Arkansas and the United States, are almost exclusively overhead lines. Approximately 50 - 60 percent of the energy produced by electricity's generating fuel is lost in this transmission.

Some of the tasks for which electricity is best suited include, lights, motors, arc-welding, electronics, etc. Electricity is not well suited for (though often used) space heating or water heating; other resources do a better

Student Worksheet

ARKANSAS AND ELECTRICITY
(Continued)

job with less cost. The market best suited to electricity is now saturated. This means that we do not need any more power plants except to meet growth in that narrow market. What we need is to develop the resources that can displace electricity when appropriate. Electricity is a very expesive and premium form of energy and should be used where only it can do the job. It should not be used where wood, wind, and direct solar can do the job more cheaply.

Today we live in a world that has far more electric power than it can use. At the end of 1979 the United States electric industry had twice the reserve capacity it needed to maintain reliable electric service. People are responding to higher prices by cutting back on consumption. This means that plants sit idle. But associated with these plants are fixed costs that a utility must bear. For that reason, the utility that experiences a decline in demand also suffers a revenue loss. This causes the utility to ask for a rate increase, which in turn effects even greater declines in consumption, resulting in even greater rate increase requests. This is the situation being faced today in Arkansas. In the future Arkansans (comsumers and utilities) must begin to stress both conservation and alternatives to central-station power plants, such as direct solar, hydropower, biomass, etc.

Answer the following questions:

1. Why are many electric power plants located in rural areas?
2. Name several environmental problems caused by the generation of electrical power.
3. Give 2 reasons why electricity is an expensive method of energy trans- mission.
4. Why would an electric power company ask people to conserve electricity when they formerly encouraged people to use more electricity?
5. How do most people respond to higher electrical costs?
6. What cycle does this response often initiate?
7. Name 3 tasks that electricity is well-suited to perform.
8. Name 2 common uses of electricity that could be accomplished more efficiently by another energy source.
9. How does the Arkansas fuel mix for electrical generation compare with that of the United States?
10. Is this trend expected to continue? Explain.

Student Worksheet

ARKANSAS AND ELECTRICITY
ANSWER SHEET

1. Safety and pollution considerations for their removal from urban sites; they require large tracts of land.

2. Particulate matter; nitrogen oxides; sulfur oxides; visual and space pollution; solid waste from coal combustion.

3. Requires transmission lines; waste 50-60 percent of the fuel used to produce electricity.

4. Generation of electricity now more expensive.

5. Cut back on consumption.

6. Utility that experiences a decline in demand suffers revenue loss, yet must still pay certain fixed costs; utility asks for rate increase, which causes greater decline in consumption, and so on.

7. Lights, motors, arc-welding, electronics.

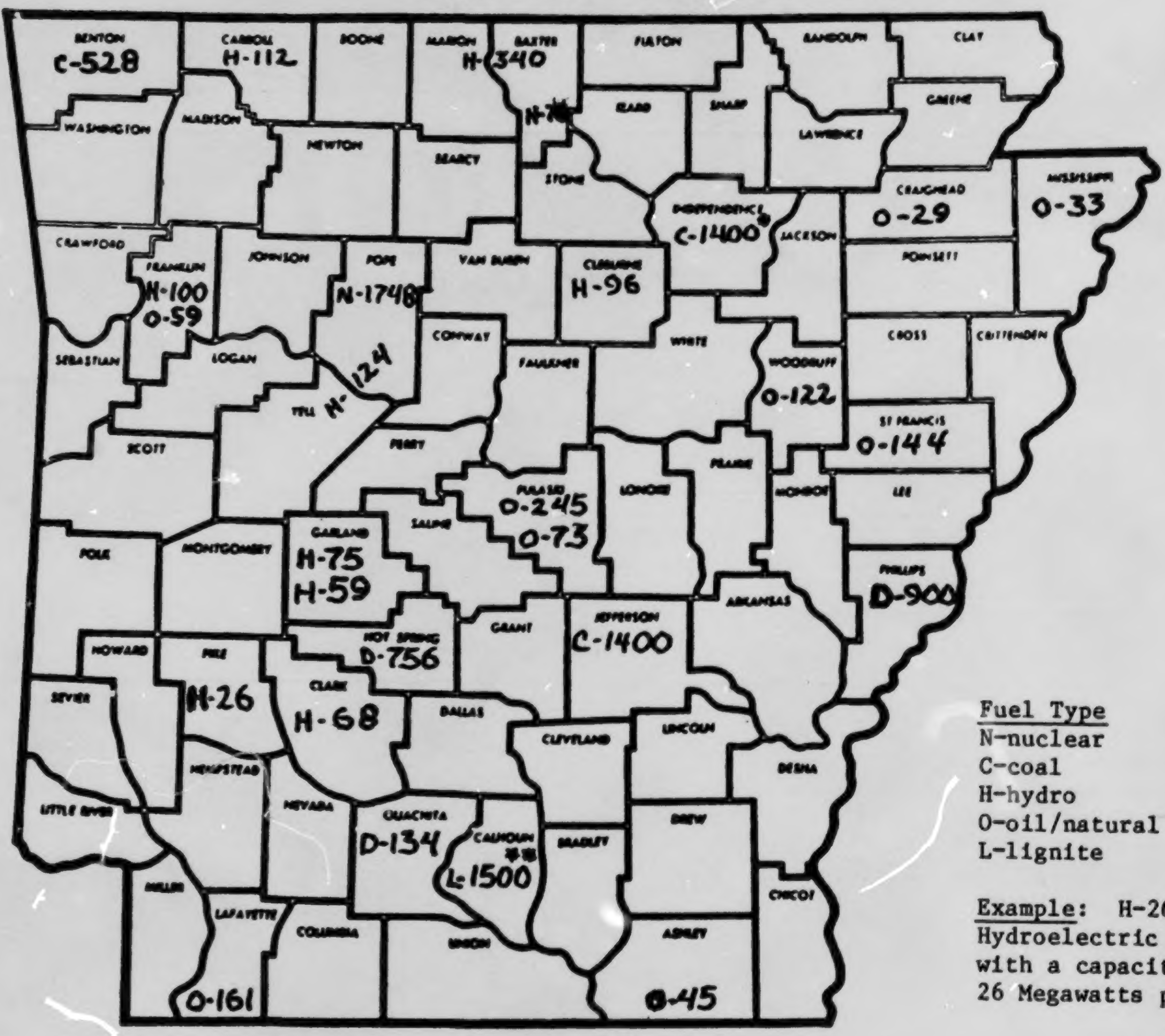
8. Space heating and water heating.

9. Arkansas uses more oil and nuclear.

10. No; during the 1980's coal and lignite-fueled power plants will begin operation and bring Arkansas more in line with the national average.

Student Worksheet

MAJOR ARKANSAS ELECTRIC POWER PLANTS
("Major": 25 + Megawatts per Day)


BENTON
C-528
CARROLL
H-112
BOONE
MARION
BAXTER
H-340
H-7
FULTON
RANDOLPH
CLAY
WASHINGTON
MADISON
NEWTON
SEARCY
STONE
IZARD
SHARP
LAWRENCE
GREENE
CRAIGHEAD
O-29
MISSISSIPPI
O-33
INDEPENDENCE
C-1400*
JACKSON
CRAWFORD
FRANKLIN
H-100
O-59
JOHNSON
POPE
N-1748
VAN BUREN
CLEBURNE
H-96
POINSETT
SEBASTIAN
LOGAN
H-124
YELL
CONWAY
FAULKNER
WHITE
WOODRUFF
O-122
CROSS
CRITTENDEN
ST FRANCIS
O-144
SCOTT
PERRY
PULASKI
O-245
O-73
LONOKE
PRAIRIE
MONROE
LEE
POLK
MONTGOMERY
GARLAND
H-75
H-59
SALINE
PHILLIPS
D-900
HOT SPRING
D-756
GRANT
JEFFERSON
C-1400
ARKANSAS
HOWARD
PIKE
H-26
CLARK
H-68
SEVIER
DALLAS
CLEVELAND
LINCOLN
DESHA
HEMPSTEAD
NEVADA
OUACHITA
D-134
CALHOUN
**
L-1500
BRADLEY
DREW
LITTLE RIVER
MILLER
LAFAYETTE
COLUMBIA
UNION
ASHLEY
CHICOT
O-161
O-45

Fuel Type
N-nuclear
C-coal
H-hydro
O-oil/natural gas
L-lignite

Example: H-26
Hydroelectric plant with a capacity of 26 Megawatts per day.

Source: Paul L. Butt. Arkansas and Energy.
*Expected completion date 1983-85.
**Expected completion date 1990-91

Anwer the following questions:

1. What fuels are now being used to generate electricity in Arkansas?
2. What is the coming fuel trend?
3. What type plant generates the most power in Arkansas?
4. What is Arkansas' approximate 1981 electrical generating capacity? For 1991?
5. Give the percentage of Arkansas's total generating capacity produced by each fuel type: For 1981. For 1991.
6. What fuel is the source of electricity in your community?
7. Is there an electric generating plant in your area?
8. Is so, what advantages does it create? Disadvantages?
9. If there is not a generating plant in your area, would you like to see one built nearby? Why or why not?
10. What fuel source would you prefer? Why?

Student Worksheet

MAJOR ARKANSAS ELECTRIC POWER PLANTS
ANSWER SHEET

1. Hydro, nuclear, coal, oil/natural gas

2. Coal

3. Nuclear

4. 1981: Approximately 7,447 Megawatts per day
   1991: Approximately 10,347 Megawatts per day

5. 1981: coal 26%
   nuclear 24%
   hydro 14%
   oil/natural gas 36%

   1991: coal 47%
   nuclear 17%
   hydro 10%
   oil/natural gas 26%

6. Answer varies

7. Answer varies

8. Answer varies

9. Answer varies

10. Answer varies

LESSON #15

CATEGORY: Conservation

TITLE: You Can Save Electricity!

INFUSE WITH SUBJECT AREA:
Math
Social Studies

MATERIALS:
None

ENERGY TYPE: Electricity

GRADE LEVEL: 7-9

TIME NEEDED: Two periods

OBJECTIVES:

1. The students will be introduced to the utility rate structure in Arkansas
2. The students will be able to read an electric meter.
3. The students will become familiar with the amount and the use of electricity consumed in their homes during one week.
4. The students will demonstrate a willingness to cut back on home energy usage, and will share with each other possible ways to conserve electricity.

TASK ANALYSIS:

The students should be able to do basic math computations.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 15.6 - 15.9.
   Read Teacher Background Information 15.4 - 15.5.

2. Steps in Lesson
   Objective #1: The students will be introduced to the utility rate structure in Arkansas.

   a. Share with the class the information on Teacher Background Information (15.4 - 15.5).
   b. Conduct a class discussion based on this information. Ask the students to comment on such things as: Fairness of the utility rate structure; ways the structure could be changed; how the structure affects their own lives.

   Objective #2: The students will be able to read an electric meter.

   a. Distribute Student Worksheet 15.6. Have the students read and discuss the worksheet material.
   b. Have the students read and record the numbers on the sets of dials; then calculate the power used from April to May and from May to June.

c. Have students answer the questions individually, then discuss the answers as a group.

Objective #3: The students will become familiar with the amount and the use of electricity consumed in their homes during one week.

a. Assign students to bring in meter readings taken at their homes at 8:00 P.M. Have them record the time, date and wattage.
b. Assign second readings to be taken exactly one week later at 8:00 P.M. Have students record these readings.
c. Have the students calculate the difference between the two readings to obtain the amount of electricity consumed in their homes during the week.
d. Hand out Student Worksheet 15.7. Have students complete the activity individually, then discuss the results as a group.

Objective #4: The students will demonstrate a willingness to cut back on home energy usage, and will share with each other possible ways to conserve electricity.

a. Challenge students to attempt to cut back on electrical energy consumption during the coming week. Have students brainstorm methods they may use to conserve electricity during this week. Remind them to look back at the appliance wattage chart on Student Worksheet 15.7.
b. During their week of attempting to conserve electricity have each student complete the three activities of Student Worksheets 15.8 - 15.9
c. Exactly one week after the second readings, have the students take third readings of their electric meters at 8:00 P.M. Have the students compare this reading with the first two readings to calculate how much electricity was saved during their week of conservation.
d. Have students with the greatest reduction in electrical energy use explain how they persuaded their families to decrease electrical use and appliances they were most able to restrict. (Take into account family size).
e. Conduct a discussion on the reasons for conserving energy:
-Save money for the family
-Save natural resources
-Reduce pollution
-Make the United States more energy independent

3. Evaluation

Note conservation efforts of students, how well their efforts succeeded and their willingness to share methods with fellow students.

4. Follow-Up Activities

Select a student to contact the electric company to learn the rates charged per kilowatt hour. Determine the amount of money saved from energy conserved during the week of student conservation.

Have students prepare posters which will be used to encourage people to turn off lights. Have them write a paragraph about why they think their poster should be awarded first prize in a poster contest. Have the class vote for winners. Display all posters prepared.

Have students create a one-minute radio or television commercial dealing with some aspect of electrical energy conservation (or any other aspect of conservation you choose). Have them present their commercials to the class. Ask: How many people does your commercial have to reach to change school or community attitudes? Who does your commercial have to convince?

TEACHER BACKGROUND INFORMATION
UTILITY RATES IN ARKANSAS

Sources:

Arkansas Energy Office. Little Rock.

Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

In the past, electric power rates have been lower for the large volume user than for the average householder who paid more per KWH because he used less electricity. This is known as a "declining block rate" structure. Such a rate structure did not tend to encourage consumer conservation, for the more he used the cheaper each "block" of electricity became. This rate structure was drawn up at a time when it cost more to get the electricity to the user than it did to actually generate the electricity itself. The structure was therefore designed to encourage increased electrical usage. Power plants are no longer cheap to construct and operate and unless demand is curbed new plants will be needed at an ever-increasing rate. So what is needed is a rate structure that will help control demand.

Conservation would be encouraged by reversing this rate structure by giving smaller users the lowest rates. Using such an inerted rate structure, the less a customer uses, the less he pays per KWH. Inverted rates are recommended outright even though few utility commissions have adopted them, since to devise them in an equitable manner is very difficult. In Arkansas we now have flat rates for most residential users, optional time-of-day rates for Arkansas Power and Light residential customers, and mandatory time-of-day rates for Arkansas Power and Light's large commercial and industrial customers. Declining block rates for electricity are no longer tolerated by the Public Service Commission (PSC).

Reasons for the current increases in electrical rates include:

1. Increased fuel costs.
2. Increased cost of borrowed money.
3. Increased construction costs.
4. Pollution control investment.
5. Peakload pricing.

Generally, the residential rate base works in the following way:

1. Most rate-settings proceedings take place at the state level, with standard guidelines established by the Federal Energy Regulatory Commission. The Arkansas PSC attempts to set rates that allow the utility enough profits to attract investors.

2. The rate-making formula determines how much annual revenue a utility is permitted to receive from its customers:

Gross Revenue - Cost of Service + Allowed Net Income

Cost of Service: Includes fuels costs, maintenance expenses, salaries, taxes, and depreciation of plant and equipment.

Allowed Net Income = Rate Base X Rate of Return

Rate Base: Represents the investment by the utility in its power plants, transmission lines, and other buildings and equipment.

Rate of Return: Determines the amount of profit a utility is permitted to earn. The amount is a percentage applied to the rate base determined by the PSC.

3. Utilities can file rate increase applications based upon their rate base and cost of service. It often takes a year or more to process these applications because of the lack of resources at the PSC and the incredible number of filings that must be dealt with by the Commission on a mandated time frame. This means less consumer representation in utility rate proceedings. Rate requests are coming in so often that commissions and advocate groups can barely keep pace. All the while, ratepayers pay for the utilitiy's costs in putting on a rate case and justifying the requested increases. Recently this lag time has been an increasing problem because of soaring costs and the need to finance new and more efficient facilities and operations.

4. A fuel adjustment clause allows the utility to pass on its increased fuel costs to the customer without applying for a rate increase.

Student Worksheet

READING YOUR ELECTRIC METER

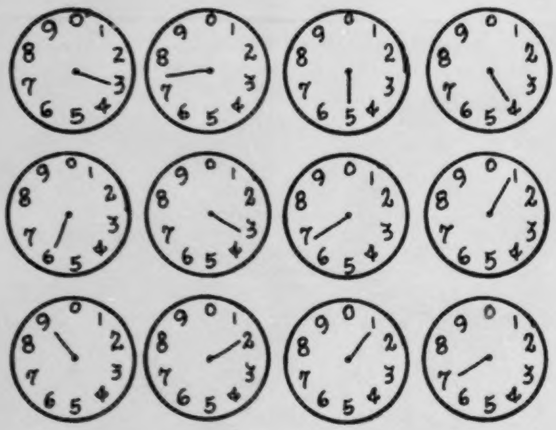
Wattage refers to the amount of energy an appliance uses. Household power is measured in kilowatt hours (KWH): Wattage multiplied by hours used, divided by 1000. For example: In 40 hours a 100-watt appliance use 4 KWH of energy.

Different appliances use different amounts of power. Even different models of the same appliance vary considerably. When electrical energy is changed to heat, such as the heating element on a range, power is used at a high rate. Insulation conserves electrical energy by keeping in the heat which electrical energy produces.

By reading the meter on your house, you can calculate exactly the amount of power used over a defined period of time.

To read the meter, record the numbers indicated by needles on the four (or five) dials. When the needle is between two numbers, read the lower number. Notice that the numbers on each dial reverse themselves. The number which is on the dial is not the number of KWH used. As the dials move around, the difference between two readings is the amount of power used.

Read the dials and record your readings. Calculate the power used from April to May and from May to June.



	Readings	Energy Used
April	= ______	
		= ________
May	= ______	
		= ________
June	= ______	

Answer the following questions:

1. Appliance energy use is measured in what units? ____________________

2. In 10 hours a 500-watt appliance uses ________ KWH of energy.

3. Restricted use of appliances with ______________________________ aid greatly in conservation of electricity in the home.

4. How does insulation aid in conservation of electricity?

Student Worksheet

READING YOUR ELECTRIC METER
ANSWER SHEET

April Reading = 3754

May Reading = 6371

June Reading = 9217

April-May Energy Used = 2617 KWH

May-June Energy used = 2846 KWH

1. Wattage
2. 5
3. Heating Elements
4. Keeps in heat produced by electrical energy

Student Worksheet

APPLIANCE EFFICIENCY

1. In column I, check all the appliances your family used during the past week.
2. In column III, estimate the number of hours your family used each appliance during the week.
3. In column IV, calculate the kilowatt hours (KWH) or the energy used by each appliance during the week. Use the following formula.

$$\frac{\text{Wattage}}{1000} \times \text{hours used} = \text{KWH}$$

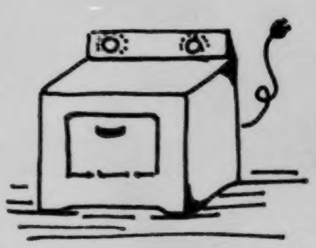
APPLIANCE	Column I	Column II Wattage	Column III Hours Used	Column IV KWH Used
Home heating unit		12,000		
Range		12,000		
Clothes dryer		5,000		
Water heater		2,500		
Air conditioner		1,500		
Broiler		1,500		
Deep fat fryer		1,500		
Portable heater		1,300		
Dishwasher		1,200		
Frying pan		1,200		
Toaster		1,200		
Iron		1,000		
Coffee maker		900		
Vacuun cleaner		650		
Frost-free refrigerator/freezer		600		
Food disposal		500		
Hair dryer		400		
Color television		350		
Black & White TV		250		
Floor polisher		300		
Infrared heat lamp		250		
Window fan		200		
Carving knife		100		
Food Blender		400		
Stereo		100		
Sewing machine		75		
Radio		70		
Shaver		15		
Toothbrush		7		
Clock		2		

LIST APPLIANCES HAVING:

Largest KWH	Smallest KWH
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.

Student Worksheet

ENERGY EFFICIENCY EXPERIMENTS



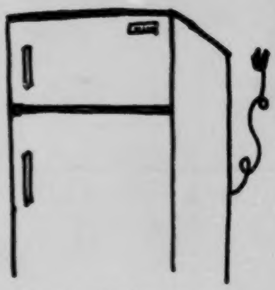
CLOTHES DRYER EFFICIENCY

Place a load of wet clothes in the dryer. After 15 minutes, open the dryer door, wait for the drum to stop turning, feel the clothes. They will probably still be damp. Close the door and restart the dryer. Do this again every 5 minutes until the clothes feel dry to your touch. Look at the timer and see how much longer the dryer was set to run. If your dryer was electric, you can figure that every wasted minute burned up about 4/5 ounce of oil, or one ounce of coal, back at the power plant. If your dryer runs on gas, figure that every wasted minute burns about 1/10 cubic feet of gas.

Two other energy-saving tips for dryers are:

1. Make sure the lint filter is cleaned out everytime the dryer is used.
2. Do not dry "half-loads" -- fill up the machine before using it.

Can you think of any other energy-saving tips for dryers?



REFRIGERATOR EFFICIENCY

You will need a thermometer for this experiment that will register as low as 30 degrees Fahrenheit. Put the thermometer inside the refrigerator, close the door and wait about 15 minutes for the thermometer to reach the inside temperature. Open the door, and working as quickly as you can, read the inside temperature. It will probably be about 40 degrees Fahrenheit.

Then, unplug the refrigerator's power cord from the wall outlet. Make sure that no one opens the door for exactly 15 minutes. Finally, open the door and take a temperature reading.

Plug the refrigerator back in (its motor will probably come on) and wait another 15 minutes with the thermometer inside. Read the thermometer again, and repeat the experiment -- with one difference. Every 5 minutes, open the door for about 30 seconds. Now when you check the thermometer after 15 minutes what do you find?

What energy-saving tip can you learn from this experiment?

Another energy-saving tip: Vacuum coils on the back of your refrigerator every 3 months or so for more efficient use of energy.
Can you think of any other tips for saving energy with your refrigerator?

CHECKLIST FOR ENERGY-EFFICIENT LIGHTING

Walk through your home with pencil and paper to see how your lights stack up. Tell you parents about your findings.

1. Are bulbs and shades free of dust that blocks light? Dirty bulbs and shades waste the light produced inside the bulbs.

Student Worksheet

ENERGY EFFICIENCY EXPERIMENTS
(Continued)

2. Are lampshades translucent (light passes through) rather than solid? Why produce light and then block it with a solid shade?
3. Are ceilings and walls light-colored to reflect more light?
4. Are "non-critical" lighting levels in your home kept as low as possible? As a rule one watt of lighting per square foot of floor area is enough for general hallway and room lighting.
5. Does everyone turn off lights when leaving a room? It does not take a lot of energy to start a light bulb, so turn off unnecessary lights.

LESSON #16

CATEGORY: Uses **ENERGY TYPE:** Nuclear Fission

TITLE: What is Nuclear Fission? **GRADE LEVEL:** 8-10

INFUSE WITH SUBJECT AREA: **TIME NEEDED:** One period

Science
Social Studies

MATERIALS:

Optional:
31 marbles
1 wide mouth glass jar
5 milliliters alcohol/duplicating fluid
1 set dominos
1 radium-dial watch or clock
Blotter paper/velvet to fit jar
Marble-size piece modeling clay
Marble-size piece dry ice

OBJECTIVES:

1. The students will gain an understanding of the use of nuclear fission energy in Arkansas and the United States.
2. The students will understand the general nature of the nuclear fission reaction.
3. The students will know the parts of a nuclear fission power plant and be able to show the flow of energy for electrical lighting from nuclear energy.

TASK ANALYSIS:

The students should be able to read and discuss material; and be able to read maps.

PREPARATION:

1. Procedure
   Duplicate Student Worksheets 16.3 - 16.9.
   Gather above-listed materials.

2. Steps in Lesson
   Objective #1: The students will gain an understanding of the use of nuclear fission energy in Arkansas and the United States.

   a. Hand out Student Worksheets 16.3 - 16.4. Have the students read and discuss the material. Have the students examine the map which indicates present and proposed nuclear facilities in the United States, and comment on their proximity to these plants.
   b. Hand out Student Worksheet 16.5. Have the students read and discuss the material.

Objective #2: The students will understand the general nature of the nuclear fission reaction.

a. Discuss Student Worksheet 16.6 on nuclear chain reactions.
b. (Optional). Use the demonstrations on Student Worksheet 16.7 to illustrate nuclear fission to the class, or have the students use these as group experiments.

Objective #3. The students will know the parts of a nuclear fission power plant and be able to show the flow of energy for electrical lighting from nuclear energy.

a. Hand out Student Worksheet 16.8. Have the students complete the activity as individuals, then discuss the answers as a class.
b. Use Answer Sheet 16.9a to guide the students in a discussion of Student Worksheet 16.9, the energy flow chart. Have the students calculate the total joules (the absolute meter-kilogram-second unit of work or energy equal to 10^7 ergs or approximately .7373 foot-pounds) for each step by subtracting lost or expended joules.

3. Evaluation

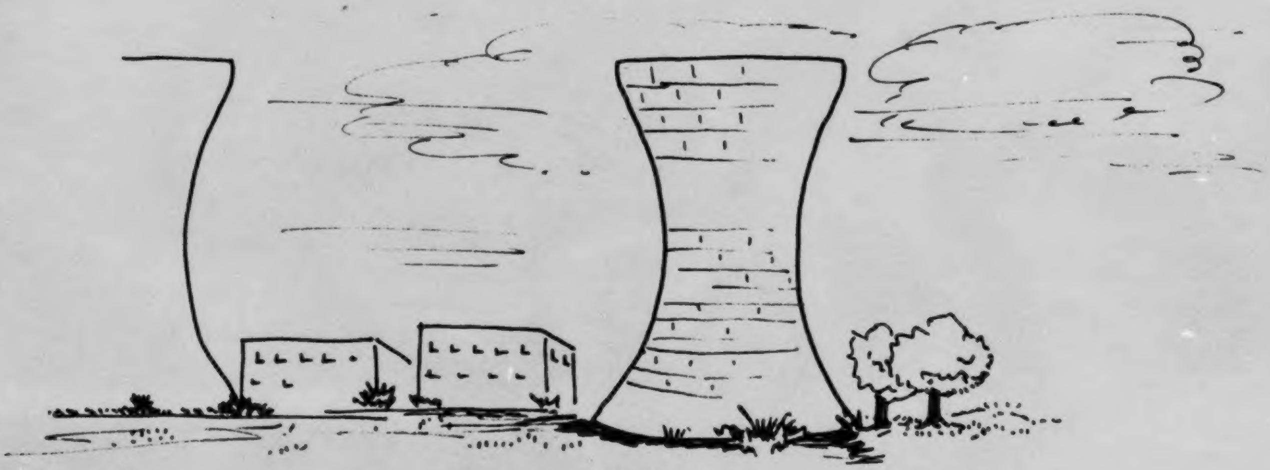
Check answers to student worksheets.

4. Follow-Up Activities

Have the students design additional activities such as those found on Student Worksheet 16.7 that demonstrate the nature of the nuclear fission reaction. Have the students show their activities to the class and/or other classes.

Have a nuclear engineer speak to the class about controlled nuclear energy production.

Contact Arkansas Power and Light Company for the loan of a simulated uranium pellet for class demonstration.



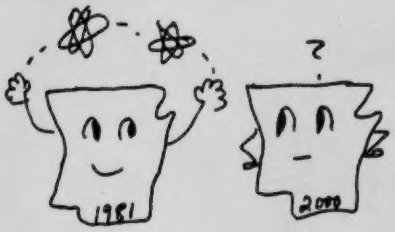
Student Worksheet

NUCLEAR FISSION

Sources:

Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

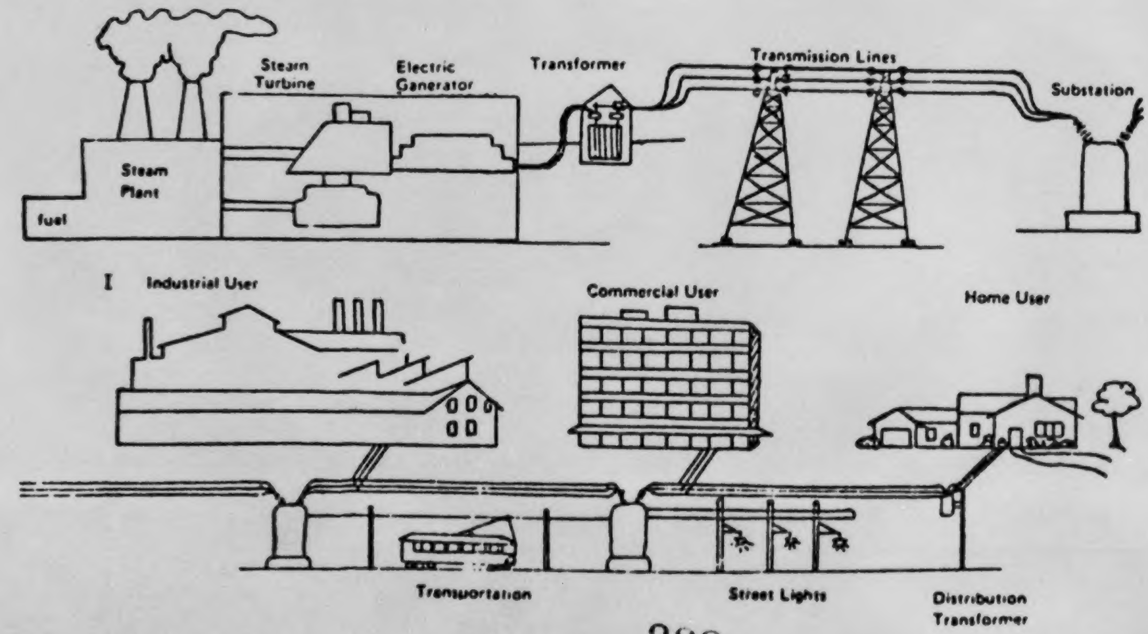
Pennsylvania's Energy Curriculum for the Middle Grades. Pennsylvania Department of Education: Harrisburg. 1977.



One of the most important, complex, and debated energy issues facing Arkansas, like the nation, is whether to use the energy from nuclear fission as a major source of electricity in the coming decades.

In the 1960's, Arkansas Power and Light Company (AP&L) and the other Middle South Utilities of which it is a part recognized the need to diversify their fuel base which, at the time, was dependent almost exclusively on natural gas. The result was Arkansas Nuclear One. The first nuclear power plant in the southwestern United States became operational in Pope County near Russellville in December of 1974. A second unit, or reactor, of Arkansas Nuclear One has been in operation since June of 1980, bringing the state's nuclear output to about 1800 megawatts. Arkansas Nuclear One accounts for about 56 percent of AP&L's total generation when both units are operating at least 65 percent of the time.

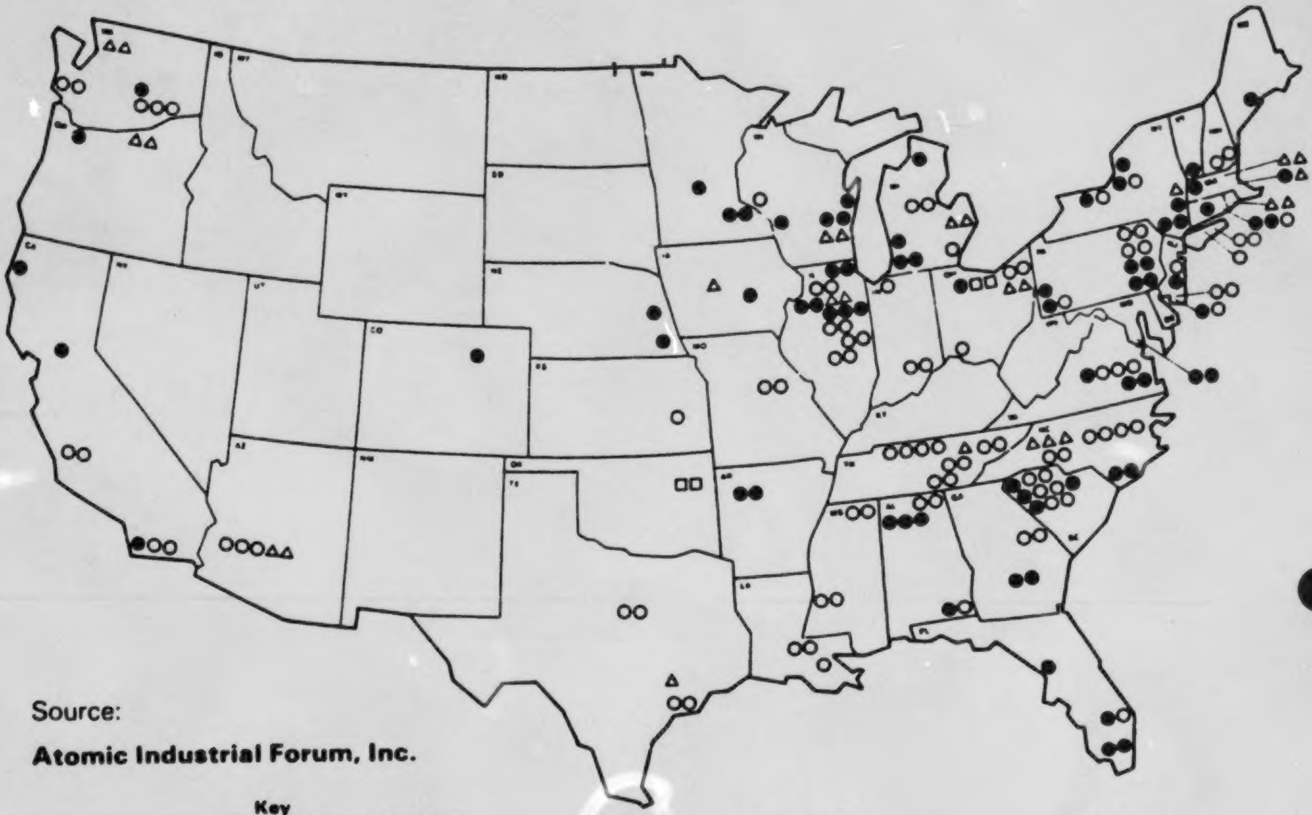
The harnessing of nuclear energy takes place in a nuclear reactor, which is part of a nuclear power plant. In the reactor, fissioning uranium produces heat energy which is used to make steam to generate electricity. The only real difference between a nuclear power plant and a fossil-fueled power plant is the method of heat production; the end product, electricity, is exactly the same. Nuclear energy, as a primary energy source, has little use other than to generate electricity or steam in large central power plants.


Steam Turbine
Electric Generator
Transformer
Transmission Lines
Substation
Steam Plant
fuel
Industrial User
Commercial User
Home User
Transportation
Street Lights
Distribution Transformer

Student Worksheet

NUCLEAR FISSION

The map below shows the location of operating and planned nuclear power plants as of January, 1979.



Source:

Atomic Industrial Forum, Inc.

Key

- ● With Operating Licenses
- ○ With Construction Permits
- □ With Limited Work Authorizations
- △ On Order

72	Reactors with operating licenses	52,396 MW
92	Reactors with construction permits	101,148 MW
4	Reactors with limited work authorizations	4,112 MW
30	Reactors on order (including 4 units not sited on map)	35,082 MW
198	Total	192,738 MW

Source: Atomic Industrial Forum, Inc.

Uranium does not burn like oil or coal. Heat is produced in the reactor by splitting heavy atoms, such as uranium-235. This process is known as "fission." A sub-atomic particle called a "neutron" strikes the center, or nucleus, of an uranium-235 atom, splitting it into fragments and releasing instantaneous heat and more neutrons. The free neutrons then collide with and split other uranium-235 atoms, causing additional heat and releasing still more neutrons that go on to split other atoms. If controlled, the result is a self-sustaining nuclear chain reaction that steadily releases enormous amounts of energy.

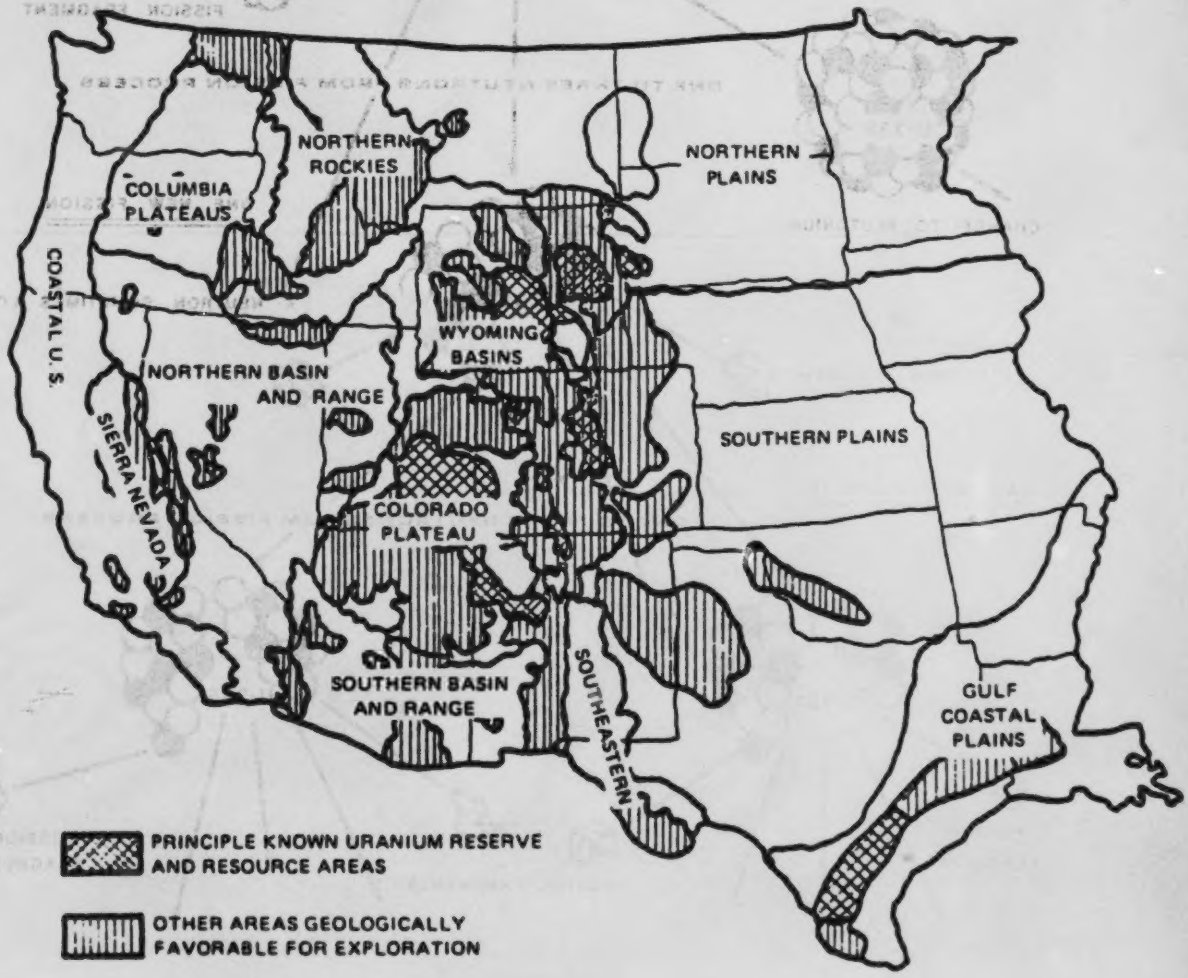
Within an operating reactor, many millions of uranium-235 atoms are splitting at any one moment. Each time uranium-235 splits, energy in the form of heat is released. The heat from the nuclear fission reaction turns water into superheated steam, and the steam spins the turbine-generator.

Student Worksheet

URANIUM RESOURCES IN THE UNITED STATES

The United States has become the leading producer of uranium in the free world. Practically all the deposits of commercial grade uranium found in the United States to date are in the western part of the country.

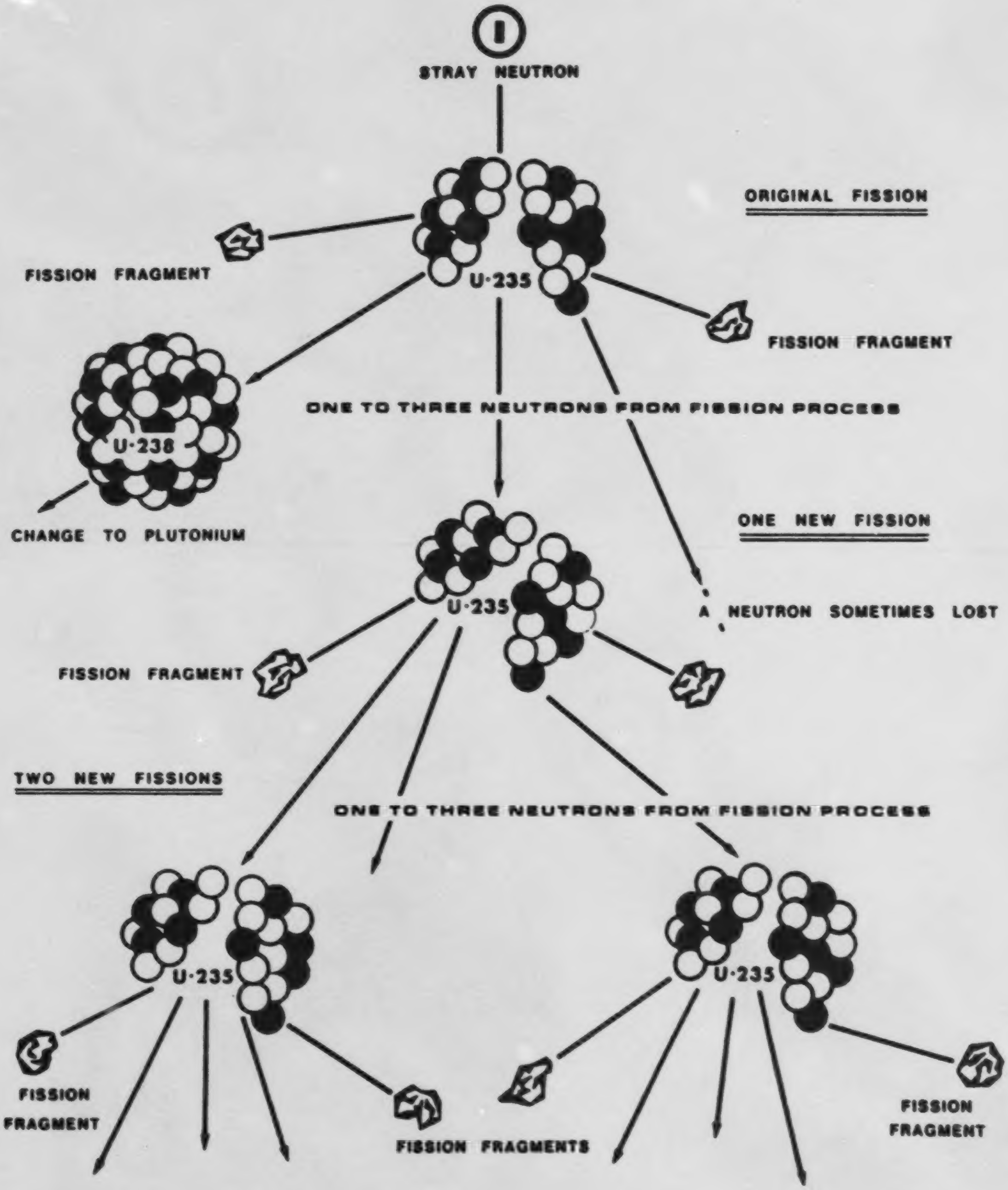
Arkansas has been one focus of exploration for additional sources of uranium. In 1975, the United States Geological Survey conducted a preliminary reconnaissance of geologic formations in southwestern Arkansas and concluded that all the necessary criteria are present for the existence of intermediate-grade uranium ore. The value of the Arkansas uranium ore, located in the general area of Hempstead, Howard, Pike and Sevier counties, is estimated by geologists at between 100 million and one billion dollars. At least three companies are presently exploring in the southwestern Arkansas area.


NORTHERN ROCKIES
COLUMBIA PLATEAUS
NORTHERN PLAINS
COASTAL U.S.
WYOMING BASINS
NORTHERN BASIN AND RANGE
SIERRA NEVADA
SOUTHERN PLAINS
COLORADO PLATEAU
SOUTHERN BASIN AND RANGE
SOUTHEASTERN
GULF COASTAL PLAINS
PRINCIPLE KNOWN URANIUM RESERVE AND RESOURCE AREAS
OTHER AREAS GEOLOGICALLY FAVORABLE FOR EXPLORATION

Source: United States Department of Energy

Student Worksheet

NUCLEAR FISSION CHAIN REACTION


STRAY NEUTRON
ORIGINAL FISSION
FISSION FRAGMENT
U-235
FISSION FRAGMENT
U-238
ONE TO THREE NEUTRONS FROM FISSION PROCESS
CHANGE TO PLUTONIUM
ONE NEW FISSION
U-235
A NEUTRON SOMETIMES LOST
FISSION FRAGMENT
TWO NEW FISSIONS
ONE TO THREE NEUTRONS FROM FISSION PROCESS
U-235
U-235
FISSION FRAGMENT
FISSION FRAGMENTS
FISSION FRAGMENT

Source: Pennsylvania Department of Education 231

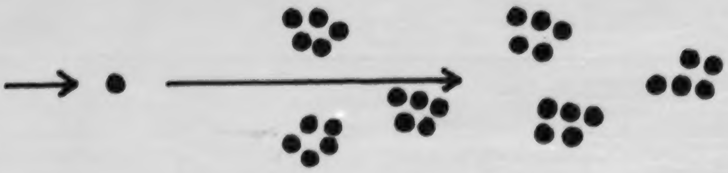
Student Worksheet

NUCLEAR FISSION SIMULATIONS

MARBLE CHAIN REACTION

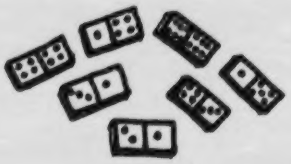
Chain reaction can be acquired through use of several clusters of marbles.

1. Place separately six clusters of five marbles each.
2. Shoot a "free" marble at a cluster in an attempt to release another "free" marble.



DOMINO CHAIN REACTION

Set up the dominos on their sides. When you tip the leading domino over as if shooting a neutron bullet into uranium, it tips two other dominos over (releases two new neutrons). In turn, the two falling dominos tip over four more. And the uncontrolled chain reaction goes on to completion. In a nuclear reactor, the chain reaction lasts years instead of a fraction of a second. You can model this slow moving reaction by setting up the dominos so that the chain reaction wastes some of the neutrons produced. Some of the dominos fall without hitting others.



CLOUD CHAMBER

A cloud chamber supercools the air so that a vapor trail will form along any passing particles, showing the trails of sub-microscopic sub-atomic particles.

Construct the chamber by gluing dark absorbent material (velvet, blotter paper) across the bottom and around the sides of a large wide-mouth jar. Leave an opening about 5 centimeters across in the bottom covering to allow for viewing and a pair of similar openings on opposite sides near the top for illumination. Use clay to support a radioactive source (luminous watch part) up from the inverted lid.

Thoroughly soak the absorbent material with about 5 milliliters of alcohol or duplicating fluid, then seal the jar. Place the inverted jar on dry ice, (dry ice is extremely cold and will damage the skin on contact) then place your hand on the bottom of the inverted jar to create sufficient heat to vaporize some of the alcohol. In about 15 minutes you should see tiny cloud tracks near the source if you shine a light across this area. Describe the cloud tracks and the directions they take. What causes the cloud tracks? What types of particles are emitted from the radium?

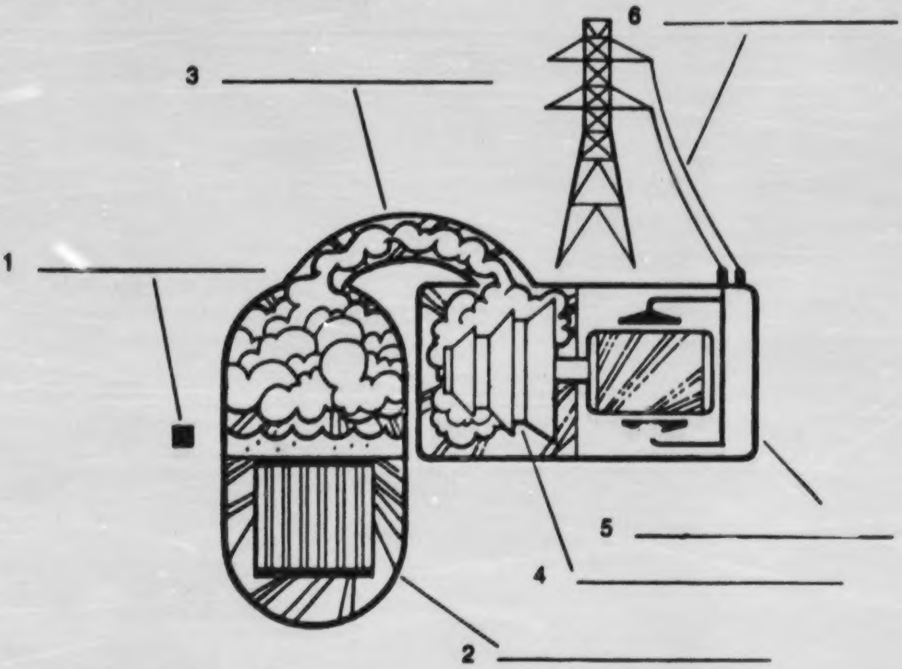
Student Worksheet

NUCLEAR FISSION ENERGY

One of the energy resources used in Arkansas is nuclear fission, created by the splitting apart of atoms of uranium. This power is captured and used to create steam which produces electricity much as the power of burning coal is used in an electric generating plant.

Label the parts of the nuclear fission plant using the words listed below:

Turbine
Generator
Transmission Lines
Fuel (1 pound)
Steam
Reactor



Place the following steps in the production of electricity from nuclear fission in order, by placing the proper number in each blank:

_____ Water leaves the reactor as steam.
_____ The water is cooled by outside water.
_____ Water removes this heat.
_____ The water flow begins again.
_____ The steam turns a turbine.
_____ The steam condenses into water.
_____ Inside the reactor the chain reaction starts.
_____ Water boils.
_____ The turbine turns a generator.
_____ The water is pumped back into the reactor.
_____ The generator produces electricity.
_____ Heat is given off when energy is produced from the atoms splitting.

Source: Pennsylvania Department of Education

Student Worksheet

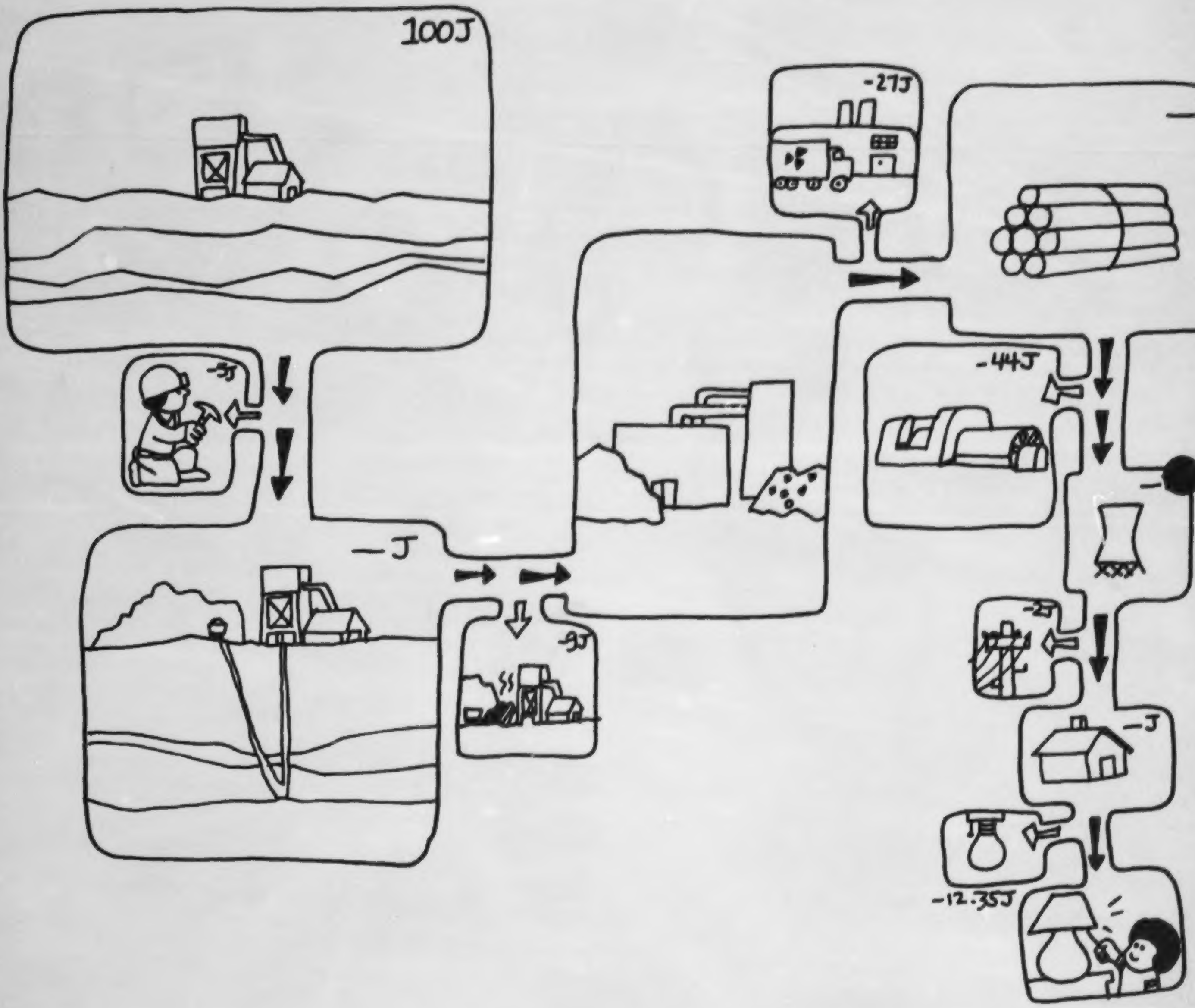
NUCLEAR FISSION ENERGY
ANSWER SHEET

1. Fuel (1 pound)
2. Reactor
3. Steam
4. Turbine
5. Generator
6. Transmission lines

5 Water leaves the reactor as steam.
10 The water is cooled by outside water.
3 Water removes this heat.
12 The water flow begins again.
6 The steam turns a turbine.
9 The steam condenses into water.
1 Inside the reactor the chain reaction starts.
4 Water boils.
7 The turbine turns a generator.
11 The water is pumped back into the reactor.
8 The generator produces electricity.
2 Heat is given off when energy is produced from the atoms splitting.

Student Worksheet

ENERGY FLOW: Electricity From Nuclear Fission


100J
-5J
—J
-9J
-27J
—J
-44J
—
-2J
—J
-12.35J

Source: Pennsylvania Department of Education

Student Worksheet

ENERGY FLOW: Electricity From Nuclear Fission
ANSWER SHEET

Energy Lost or Expended

100 J of nuclear energy
in uranium ore in the ground

↓

95% Step Efficiency
Energy used in mining and in preparation for mining

95 J of nuclear energy
in uranium
at the mouth of the mine

↓

90% Step Efficiency
Energy represented in the discarded material and used in "milling" the ore

86 J of nuclear energy
in "yellowcake",
a somewhat purified uranium ore

↓

69% Step Efficiency
Energy used in transportation, uranium enrichment, pellet production, and fuel bundle fabrication

59 J of nuclear energy
in enriched uranium fuel pellets
which are in metal tubes
and assembled in fuel bundles

↓

26% Step Efficiency
Energy expended in operating the power plant equipment and heat lost to the cooling water in the turbine condenser

15 J of electrical energy
leaving the nuclear power plant

↓

85% Step Efficiency
Energy lost as heat which was produced by the electrical resistance in the wires of the transmission power lines, etc.

13 J of electrical energy
at a home or other kind of end use

↓

5% Step Efficiency
Energy expended to maintain the filament of the light bulb at a high temperature (incandescent) but lost as heat to the air.

0.65 J of light energy

*This flowchart is written as if all the energy in the uranium fuel were converted to heat energy in the reactor. In fact, only about 1% of this energy is converted. Since the unused fuel can, in theory, be recycled, this low conversion efficiency is not considered in this chart.

LESSON #17

CATEGORY: Impacts

ENERGY TYPE: Nuclear Fission

TITLE: Benefits and Concerns of Nuclear Fission

GRADE LEVEL: 8-10

SUBJECT AREA:
Science
Social Studies

TIME NEEDED: One period

MATERIALS:

Current reference materials on nuclear fission energy

OBJECTIVES:

1. The students will consider some environmental impacts of nuclear fission power plants.
2. The students will consider some problems of nuclear waste disposal.
3. The students will consider some benefits and some concerns of nuclear fission power plants.

TASK ANALYSIS:

The students should be able to do basic math computations; do independent research; and be able to discuss materials and reach conclusions on that material.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 17.3 - 17.7.
   Gather above-listed materials.

2. Steps in Lesson
   Objective #1: The students will consider some environmental impacts of nuclear fission power plants.

   a. Using Student Worksheet 17.3, have the students compute their own approximate radiation dosage.
   b. Have the students use reference materials to conduct research on nuclear fission power plants. Have them consider especially such topics as:
      -Known plant accidents (such as Three Mile Island)
      -Plant safe-guard efficiency
      -Possibility of human error
      -Possibility of sabotage
      -The "China Syndrome" possibility
      -Safety of people living near plant facilities
      -Any other topics of special interest to the student(s)
   c. Conduct a class debate on the Three Mile Island crisis.
      Consider such questions as:
      -What went wrong?
      -How is Three Mile Island similar to Arkansas Nuclear One?
      -Could this happen in Arkansas?

d. Have the class role-play the Meltdown Scenario on Student Worksheet 17.4.

Objective #2: The students will consider some problems of nuclear waste disposal.

a. Hand out Student Worksheet 17.5. Have the students read and discuss the material.
b. Have students list three methods of nuclear waste disposal. Have them give advantages and disadvantages of each. Discuss which of these methods seem feasible for Arkansas. Discuss how they would feel about living near a nuclear waste dump such as Arkansas Nuclear One's deep water pool. Discuss possible reasons for Arkansas Power and Light's decision to enlarge this pool.
c. Have students devise an improved method for disposal of nuclear waste materials, keeping in mind, both economic and environmental concerns.

Objective #3: The students will consider some benefits and some concerns of nuclear fission power plants.

a. Hand out Student Worksheets 17.6 - 17.7. Have students read and discuss the material.

3. Evaluation

Check answers to student worksheets.

Use oral evaluation of student knowledge and understanding during class discussions.

4. Follow-Up Activities

Conduct a class debate on: "Nuclear fission power should be increased in Arkansas."

Have a nuclear engineer speak to the class about controlled nuclear energy production; have an anti-nuclear activist speak also.

Student Worksheet

COMPUTE YOUR OWN RADIATION DOSAGE

This exercise will give you an idea of the amount of radiation you are exposed to every year. The unit of radiation used here is the millirem.

	Common Source of Radiation	Your Annual Inventory (mrem/year)
1. WHERE YOU LIVE	Location: Cosmic radiation at sea level	40
	Add 1 for every 100 feet of elevation where you live	____
	House construction: Wood 35 Concrete 50 Brick 75 Stone 70	____
	Ground (U.S. Average)	56
2. WHAT YOU EAT DRINK AND BREATHE	Water and food (U.S. Average)	25
	Air (U.S. Average)	5
3. HOW YOU LIVE	Jet Airplanes: Number of 6000-mile flights x 4	____
	Radium Dial Wrist Watch: Add 2	____
	Television Viewing: Black & White: No. hours per day x 1	____
	Color: No. hours per day x 2	____
	X-ray Diagnosis and Treatment Limb x-ray: 420 Chest x-ray: 150 Stomach x-ray: 350 Colon x-ray: 450 Head x-ray: 50 Spinal x-ray: 250 Gastrointestinal tract x-ray: 2000 Dental x-ray: 20	
4. HOW CLOSE YOU LIVE TO A NUCLEAR PLANT	At Site Boundary:	5
	One Mile Away:	.5
	Five Miles Away:	.05

Compare your radiation dosage to the U.S. Average of 200 mrem/year

SOURCES: San Diego Section, American Nuclear Society (#1-3) Arkansas Power & Light (#4)

17.3 / 17.4

Student Worksheet

NUCLEAR WASTE DISPOSAL

Source:

Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

The radioactive wastes from nuclear power plants is a cause for concern. Every year or two, a nuclear power plant must be shut down so that some of the depleted fuel bundles in its core can be replaced. This depleted fuel is highly radioactive, and must be maintained in carefully controlled storage.

Three methods are utilized to dispose of radioactive wastes:

1. In dilution and dispersion, low-level wastes are released into the air, water, or ground to be diluted to presumably safe levels. As wastes proliferate, this already hazardous practice will begin to add significantly to artificial radiation levels in the environment. In the long term, "dilution is not the solution to pollution."

2. Delay and decay is used for radioactive wastes with relatively brief half-lives. They are stored as liquids or slurries in tanks. After 10 to 20 times their half-lives, they decay to presumably harmless levels, at which time they can be diluted and dispersed to the environment.

3. Concentration and containment is used for highly radioactive wastes with long half-lives. These wastes must be stored for tens, hundreds, or thousands of years, depending on their composition. Such wastes are not only extremely radioactive but also are thermally hot. Official assurances from nuclear scientists and the federal government that the problem of long-term waste storage can be solved has not satisfied many people who feel the expanded use of nuclear fission should not proceed until the waste storage problem has been solved.

In 1979, about 6,000 tons of spent fuel from United States nuclear power plants were being stored temporarily underwater in specially constructed pools at the nuclear power plant sites until a method for long-term disposal can be found. By the end of the 1980's the amount of stockpiled used fuel is expected to be as much as 38,000 tons. Many experts doubt that such a large quantity of spent fuel can continue to be stored safely at nuclear plant sites. Therefore, unless one or more permanent storage sites are developed by the 1980's, some nuclear power plants may be forced to close and new plant construction may be halted.

Arkansas Nuclear One will exhaust its capacity to store used fuel in the mid-1980's. Arkansas Power and Light has stated that it plans to extend the life of its storage facilities at the plant through the mid-1990's by enlarging its deep-water pool, at a cost of about 2-1/2 million dollars. The company also could build a separate long-term storage facility at the plant site, but it is estimated that could cost as much as the power plant itself.

Student Worksheet

NUCLEAR FISSION CONSIDERATIONS

Source:

Arkansas Energy Office

There has been a virtual halt to new reactor orders in the United States over the last 5 to 6 years. Cancellations and deferrals of previously ordered reactors far out-weigh the handful of new orders placed by utilities in recent years. The issues that are critical to this situation include safety/emergency planning, nuclear plant cost, waste disposal, and governmental regulation.

Safety/Emergency Planning

Three Mile Island spawned a host of plant modificiations, additional operator training requirements, more stringent safety standards and rules, and expanded licensee and state government evaluation preparations. Before Three Mile Island these substantive safety improvements were not deemed necessary. The question should be asked: "Were we living next to a dangerous technology without adequate safeguards in place?" A great many lessons were learned as a result of Three Mile Island, and they have already affected the nuclear industry in a serious way. Many nuclear utilities find it almost impossible to manage and operate a nuclear plant. Capacity factors (a measurement of a plant's efficiency) are falling off precipitously. This is the case at Arkansas Nuclear One. As a result, Arkansas Power and Light has asked the Public Service Commission to make dramatic changes in its fuel adjustment clause. The Company wants the rate-payer to bear a much greater share of the risks associated with operating a nuclear plant.

Nuclear Plant Costs

From 1975 to 1978 nuclear plant costs soared by 392 percent. This compares to a general inflation rate during the same period of only 60 percent. The future costs of nuclear plants also look unpromising. Assuming construction began in 1979, their costs would easily be 60 percent greater than those of new coal plants with expensive environmental equipment.

Waste Disposal

Methods of waste disposal are highly uncertain at this time. Of importance would be a study of the impending state/federal and state/state struggle over waste disposal. After a technology is chosen, who decides where the waste will go? Will the federal government force it on certain states? What about states that do not harbor nuclear plants, yet are asked to handle the high-level wastes generated by neighbors? This issue coupled with the others has added to the critical uncertainty surrounding nuclear fission power.

Government Regulation

Most utilities blame government, both federal and state, for the problems that plague nuclear power. No matter where the blame lies, nearly all analysts predict that nuclear will experience greater regulation in the future. Three Mile Island has made this a virtual certainty. This clouds the nuclear future even more in the view of utilities, investors, and public utility commissions.

Student Worksheet

BENEFITS AND CONCERNS OF NUCLEAR FISSION

The following is a list of benefits and concerns associated with nuclear fission power plants. Read this list and put a (B) in the blank if it is a benefit, a (C) if it is a concern.

_____Less need for mining and transport of fuel.

_____No pollutants from burning fuel.

_____Less reliance on imported fuel.

_____Could be targets for terrorists.

_____Reactors produce less waste than fossil-fuel plants.

_____Higher cost to build and high cost of decommissioning.

_____Large amounts of plutonium could lead to spread of nuclear weapons.

_____Possibility of meltdown and radiation escape.

_____Radioactive waste must be handled and disposed of safely for thousands of years.

_____Larger generating capacity than fossil-fuel plants.

_____Much less fuel needed than for fossil-fuel plants.

_____New stringent training regulations and safety regulations with greater government regulation in the future.

_____Less efficient than modern fossil-fueled plants.

_____Uranium is a finite resource.

LESSON #18

CATEGORY: Alternatives

ENERGY TYPE: Biomass

TITLE: Organic Energy

GRADE LEVEL: 9-12

INFUSE WITH SUBJECT AREA:
Science
Social Studies

TIME NEEDED: One period

MATERIALS:
None

OBJECTIVES:

1. The students will be familiar with the nature of biomass.
2. The students will become familiar with methods of obtaining energy from biomass.
3. The students will recognize some benefits and some limits of biomass.

TASK ANALYSIS:

The students should be able to read and understand charts.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 18.3 - 18.7.

2. Steps in Lesson
   Objective #1: The students will be familiar with the nature of biomass.

   a. Hand out Student Background Information 18.3. Have students read over the material, then discuss in class.

   Objective #2: The students will become familiar with methods of obtaining energy from biomass.

   a. Hand out Student Worksheet 18.4. Discuss the chart in class.
   b. Hand out Student Worksheet 18.5. Have the students complete the chart individually, then discuss as a class.

   Objective #3: The students will recognize some benefits and some limits of biomass.

   a. Place the following two headings on the chalkboard:
      Benefits Limits
      Have the students brainstorm as many factors as possible about biomass that would go under each heading.
   b. Hand out Student Worksheet 18.6. Discuss the material and add to the list of benefits and limits, if necessary.
   c. Hand out Student Worksheet 18.7. Have the students work the activity in small groups, then discuss as a class.

3. **Evaluation**

Check answers to student worksheets.

4. **Follow-Up Activities**

Make a field trip to: An industry or municipality using garbage power, a gasohol station or plant, or a paper mill using waste power.

Invite a class speaker who is involved in the production or use of energy from biomass.

Check out the possibilities of using biomass energy in your own community.

Order the following factsheets for classroom material from:

Department of Energy
Technical Information Center
Box 62
Oak Ridge, Tennessee 37830

Factsheet Titles: "Fuels from Plants" (Bioconversion) and "Fuels from Wastes." (Bioconversion).
Free.

Better eat up fast!
Those humans have an
unending appetite for
energy these days!

STUDENT BACKGROUND INFORMATION

Sources:

Paul L. Butt. *Arkansas and Energy: A Look at the Alternatives*. Arkansas Ecology Center: Little Rock. 1979.

Amanda Grace. *Biomass*. United States Department of Energy: Washington, D.C. 1979.

Arkansas Energy Office. Little Rock.

Organic matter such as trees, agricultural and forestry residues, aquatic plant life, and animal and urban wastes represents a great potential as an energy source. Organic matter is collectively known as "biomass." Biomass is usually considered a solar-related energy source because all organic matter depends upon sunlight and the process of photosynthesis. Biomass, in any form from algae to trees, has a remarkable uniform heat content which, when dry, is about half that of the better coals. Pound for pound, dry biomass has about the equivalent heat value of Arkansas lignite (low-grade coal).

At one time biomass in the form of wood accounted for most of Arkansas' energy supply. As late as 1950 about 2/3 of Arkansas' counties used wood as the primary home heating source. In 1970, this was still the case in Marion, Newton and Searcy counties. Wood consumption in Arkansas in 1978, was estimated at approximately 360,000 cords; equivalent to about 1/3 of the natural gas used during that year.

For Arkansas, an agricultural state with extensive wood producing and using industries, biomass represents a large potential for energy. Possible sources of biomass energy for Arkansas are as follows:

WASTES (byproducts)

Forest Products

Sawdust
Bark
Paper pulp
Wood shavings
Scrap lumber
Wood dust
Paper

Agricultural and Food Processing

Fruit pits
Walnut shells
Rice hulls
Corn cobs
Manures (poultry, hog, cattle)
Sugarcane bagasse
Cotton gin trash

Municipal

Sewage
Solid Wastes

RESIDUES (left-overs)

Forest

Noncommerical timber
Diseased trees
Slash

Agricultural

Straw from:
- rice
- wheat
- barley
- oats

Corn stalks
Soybean residue
Kudzu

Student Worksheet

SIX MAJOR WAYS TO CONVERT BIOMASS

	METHOD	PROCESS	SOURCE	RESULTS	ENERGY CONSUMER
BIOCONVERSION Chemical reaction caused by treating biomass with micro-organisms	Anaerobic digestion	Controlled decay in the absence of oxygen	Manure, agricultural waste, sewage, paper, seaweed, algae	Synthetic gas	Municipal sewage treatment plants, farms
	Fermentation	Carbohydrates are fermented and distilled	Grain, sugar cane juice, molasses	Ethanol	Internal combustion engines
THERMOCHEMICAL CONVERSION Uses heat to produce chemical reaction in biomass	Direct Combustion	Burns	Forest and agricultural waste, wood and lumbermill waste	Steam, electricity heat	Industries, utilities, homes
	Gasification	Heats waste in a limited amount of air	Corn cobs, fruit pits, rice hulls, walnut shells, wood product waste food waste, cotten gin trash	Synthetic natural gas (SNG), methanol carbon monoxide ammonia, hydrogen synthetic gasoline	Paper and lumber companies, municipalities
	Pyrolysis	Breaks down biomass with heat in the absence of oxygen at lower temperatures	Municipals solid waste, manure, agricultural, wood waste, paper mill waste	Oil, charcoal synthetic gas	Paper and lumber companies
	Liquefication	Catalytic process involving reaction with hydrogen/ carbon monoxide at high pressure and moderate temp.	Same as for gasification	Crude oil-like material	Direct combustion

Student Worksheet

BIOMASS ENERGY APPLICATIONS

Complete the following chart:

ENERGY CONSUMER	ENERGY PRODUCT	EXAMPLE OF RESOURCES USED	EXAMPLE OF CONVERSION PROCESS
Paper and Lumber Companies			
Municipalities			
Homeowners, Space Heating Users			
Cars, Trucks			
Utilities			
Other			

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Student Worksheet

BIOMASS ENERGY APPLICATIONS
ANSWER SHEET

ENERGY CONSUMER	ENERGY PRODUCT	EXAMPLE OF RESOURCES USED	EXAMPLE OF CONVERSION PROCESS
Paper and Lumber Companies	Steam, Electricity, Heat	Forest residues, slash, sawdust, bark	Direct Combustion, Gasification, Pyrolysis
Municipalities	Electric power and gas	Wood wastes, sewage, solid municipal waste	Anaerobic digestion, Gasification
Homeowners, Space Heating Users	Heat	Wood, biomass residues	Direct combustion in wood stoves
Cars, Trucks	Gasohol	Agriculture surplus	Fermentation
Utilities	Electricity Steam, Heat	Forest, agricultural wastes and residues	Direct combustion
Other			

Student Worksheet

BENEFITS AND LIMITS OF BIOMASS

BENEFITS

1. Readily available in current wastes and residues and potentially available from energy crops.
2. Renewable and inexhaustible if properly managed.
3. Use of residues and wastes can lessen environmental problems. Wood wastes, garbage, and agricultural residues are frequently burned or used in landfills; they could instead be used to produce energy. Using logging residues to produce energy can reduce fire hazard, tree diseases and insect infestation.
4. Safer and cleaner than many energy sources. Organic waste is typically sulfur-free, and air pollutants can be lower in biomass combustion systems than in those that use conventional fuels.
5. Does not carry the risks of spent fuel disposal or oil tanker spillage.
6. Already competes economically today in the forest products and food processing industries and makes a significant contribution to the national energy budget.
7. Efficient conversion processes. Usually more economical to use residues on-site for electricity production (even on small scale) than to transport coal from the mine to the generating plant.
8. Flexible resource due to variety of sources, conversion processes, and energy end-products.
9. Can reduce dependence on foreign fuel sources and prices over which we have little control.
10. Minimal storage problem.

LIMITS

1. Must become more competitive in cost, convenience, and reliability with conventional energy sources.
2. Additional research is needed on conversion processes other than direct combustion.
3. Overuse of biomass resources could affect future availability and have a detrimental effect on the quality of our soil, air, and water.
4. Benefits of using biomass must be weighed against benefits derived from using it to create other economically valuable products.
5. New technologies require changes in attitudes and conventional practices.
6. Yields low net-useful energy. When collected and burned near its sources, biomass has moderate net energy yield, but yields tend to be low when biomass must be collected and transported.
7. Most biomass material is widely dispersed.

Student Worksheet

BIOMASS RATING CHART

FACTOR	GOOD	FAIR	POOR	EXPLAIN RATING
Availability				
Renewable/nonrenewable				
Energy Independence				
Air pollution				
Water pollution				
Economic effects				
Efficiency				
Flexibility				
Sources				
Storage				
Convenience				
Reliability				
Land Use				
Attitudes				
Energy content				
Cost				
Other				

LESSON #19

CATEGORY: Alternatives

ENERGY TYPE: Biomass

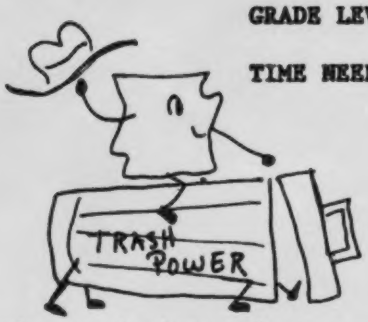
TITLE: Trash Power

GRADE LEVEL: 7-9

TIME NEEDED: One period

INFUSE WITH SUBJECT AREA:
Science
Social Studies

MATERIALS:
None



OBJECTIVE:

The students will understand that Arkansas can use trash as an energy source.

TASK ANALYSIS:

The students should be able to read material and answer questions from that material; and be able to conduct independent research.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 19.3 - 19.4.

2. Steps in Lesson
   Objective: The students will realize that Arkansas can use trash as an energy source.

   a. Hand out Student Worksheets 19.3 - 19.4. Have the students read, then discuss the material. Answer the questions as a class.
   b. Have the students investigate the possibilities of energy from waste in their own community. Set up the following investigative commmittees:
      - Check with your community's sanitary landfill and/or other waste disposal facility. Find out how much waste is generated in your community and what is done with it.
      - Survey the community's industries. Find out if there are any producing energy by burning their own waste and/or if any produce waste that could be burned to produce energy.
      - Take a neighborhood trash survey. Estimate the amount of trash produced by individual families. The United States Department of Energy has estimated that the average household in our "throwaway" society could potentially provide about 37 percent of its energy needs from the wastes it produces.
      - Survey citizens of your community to find out if they would be willing to separate their trash into combustibles and noncombustibles. Municipal solid wastes are about 80 percent organic, thus 80 percent combustible.
      - Survey the retail establishments in your community. Find out if they would be willing to burn their combustible trash to produce energy; or if they would save their trash for pick-up by an agency that would burn it for energy.

-Interview a representative of the local highway department. Find out the possiblilities of your community using ash from burned waste as road bed or fill materials.

Have each committee report to the class on its findings.

c. Have a class committee assimilate the material collected by the various groups and present a copy of the findings to a community official.
d. Write an article on the results of the trash survey for the school and/or community newspaper.

3. Evaluation

Check answers to student worksheets.

4. Follow-Up Activities

Take a class field trip to your community landfill or other waste disposal facility.

If possible, take a field trip to the solid waste heat recovery facility in Siloam Springs, Osceola, Blytheville or North Little Rock.

Student Worksheet

ENERGY RECOVERY

Source:

Arkansas Energy Office. Little Rock

Solid waste

Every day, Arkansas disposes of approximately 5,000 tons of solid waste. Solid waste includes such things as garbage, trash, street refuse, construction wastes, and dead animals. If this waste is not disposed of properly, it causes air and water pollution. Usually, waste is placed in a dump or sanitary landfill. When this happens, all of the waste materials such as paper, glass, tires, and aluminum are buried and are no longer useful and landfills are very expensive to operate. Recycling some of the materials is one way to re-use the resources and conserve energy. Recycling is one type of resource recovery. Another kind of resource recovery is called energy recovery.

Help! save us!

To recover the energy, solid waste is placed in an incinerator which burns the waste. The energy released from incineration is used to produce steam, hot water or hot air. Many industries can use the hot air, hot water or steam in the place of electricity, gas, or oil, to make their products.

Small incinerators such as the ones used in Arkansas burn the waste at medium temperatures with a controlled amount of air, so that they do not produce air pollution as some incinerators do. Siloam Springs, Arkansas, was the first city in the United States to use this type of incinerator.

Burning waste reduces the volume of the waste by 85 to 90 percent. It can then be taken to a landfill, where it does not take up so much space and will not cause pollution or, in some cases, the ash can be used as road bed or fill materials.

SILOAM SPRINGS
BLYTHEVILLE
OSCEOLA
NORTH LITTLE

Four cities in Arkansas ranging in population from 6,400 to 62,000, (Siloam Springs, Osceola, Blytheville and North Little Rock) incinerate their waste and recover the heat generated to fuel local industry.

Another city, Batesville, population 7,200, plans to begin doing so in 1981 and feasibility studies are underway in Jefferson County, Fort Smith and a partnership of Ashley, Drew, Desha, Lincoln and Chicot Counties.

Georgia-Pacific Corporation of Crossett uses a cheap, renewable energy: its own waste wood chips. The waste is incinerated, without any preprocessing or separation, using a starved-air process that produces exhaust that meets federal and state clean air regulations.

Student Worksheet

ENERGY RECOVERY

Answer the following questions:

1. What type of waste can be burned to produce energy?

2. Why is burning of solid waste known as energy recovery?

3. Energy released from burning of trash is used to produce ________________, ________________________________, or ________________________________.

4. What energy resources can be conserved by the use of energy recovery processes?

5. What is the difference in recycling and energy recovery?

6. Name 2 ways combustion of solid waste is good for the environment.

7. ________________________ was the first city in the United States to use a small, moderate temperature, controlled air incinerator to burn solid waste.

Label as true or false:

_____1. Only large cities with huge volumes of wastes can benefit from energy resource recovery by burning of wastes.

_____2. All incinerators produce significant amounts of air pollution.

_____3. Arkansas disposes of 5,000 tons of solid waste material each day.

_____4. Burning wastes reduces their volume about 10 percent.

_____5. Landfills are often used to dump solid wastes because of their low overhead.

Student Worksheet

ENERGY RECOVERY
ANSWER SHEET

1. Solid waste including garbage, trash, street refuse, construction waste and dead animals.

2. It recovers the energy in the materials that would otherwise be lost.

3. Steam, hot water, hot air.

4. Electricity (secondary), natural gas and oil (primary).

5. Recycling is re-use of materials; energy recovery is re-use of the energy found in the materials to produce more energy.

6. Conserves fossil fuels; prevents air pollution from their combustion; reduces volume of waste 85 to 90 percent.

7. Siloam Springs, Arkansas

True/False

1. False

2. False

3. True

4. False

5. False

LESSON #20

CATEGORY: Sources

ENERGY TYPE: Geothermal

TITLE: It's Hot Stuff!

GRADE LEVEL: 8-10

TIME NEEDED: One or two periods

INFUSE WITH SUBJECT AREA

Science
Social Studies
Reading

MATERIALS:

Small package of modeling clay
Metal funnel or coffee percolator pipe
Container large enough to hold funnel
Water to fill containter 1/4th full
Ring stand
Bunsen burner
Optional:
Large world map
Pictures of geysers and hot springs

OBJECTIVES:

1. The students will gain an understanding of the general nature of geothermal energy.
2. The students will be able to describe the types of geothermal wells.
3. The students will become familiar with geothermal potential in Arkansas.

TASK ANALYSIS:

The students should be able to read and interpret maps; be able to read material, then answer questions based on that material.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 20.3 - 20.8.
   Gather above-listed materials.

2. Steps in Lesson
   Objective #1: The students will gain an understanding of the general nature of geothermal energy.
   a. Hand out Student Worksheet 20.3. Do the experiment as a class demonstration or as individual student experiments. Discuss the answers in class.
   b. Have student groups research and report to the class on the history of volcanos such as: Mount Ranier, Kilauea Iki, Vesuvius, Popocatepetl, Mount Saint Helens, and Krakatoa.
   c. (Optional). Show on a map the famous hot springs and geysers of the world. Display pictures of geysers and hot springs.

   Objective #2: The students will be able to describe the types of geothermal wells.

a. Hand out Student Worksheets 20.4 - 20.6. Have the students read the material, then fill out the charts individually. Discuss the charts as a group.

Objective #3: The students will become familiar with geothermal potential in Arkansas.

a. Refer back to Student Worksheets 20.4 - 20.5 for Arkansas geothermal information.
b. Hand out Student Worksheet 20.7. Have the students individually answer the questions. Discuss the answers as a group.
c. Have students brainstorm limiting factors to geothermal energy in Arkansas, listing them on the chalkboard.
d. Hand out Student Worksheet 20.8. Discuss and add to the list of limiting factors.
e. Have the students brainstorm possible solutions to the limiting factors.

3. Evaluation

Check Answers to Student Worksheets.

Oral evaluation during class discussions.

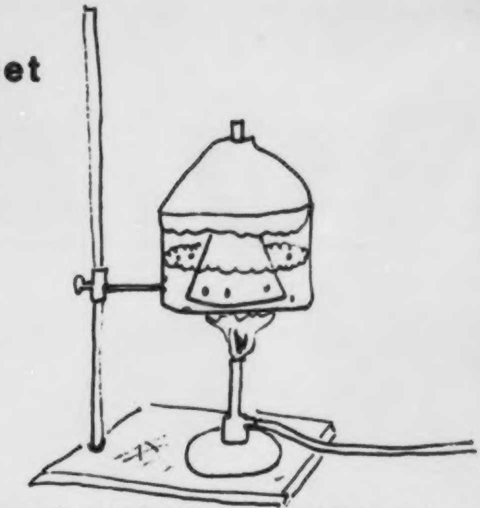
4. Follow-Up Activities

Have the students trace the use of geothermal energy by various groups of people throughout history.

Have the students describe their feelings when they first saw a picture of a geyser, such as "Old Faithful." They may use such media as pictures, poems, stories, or songs.

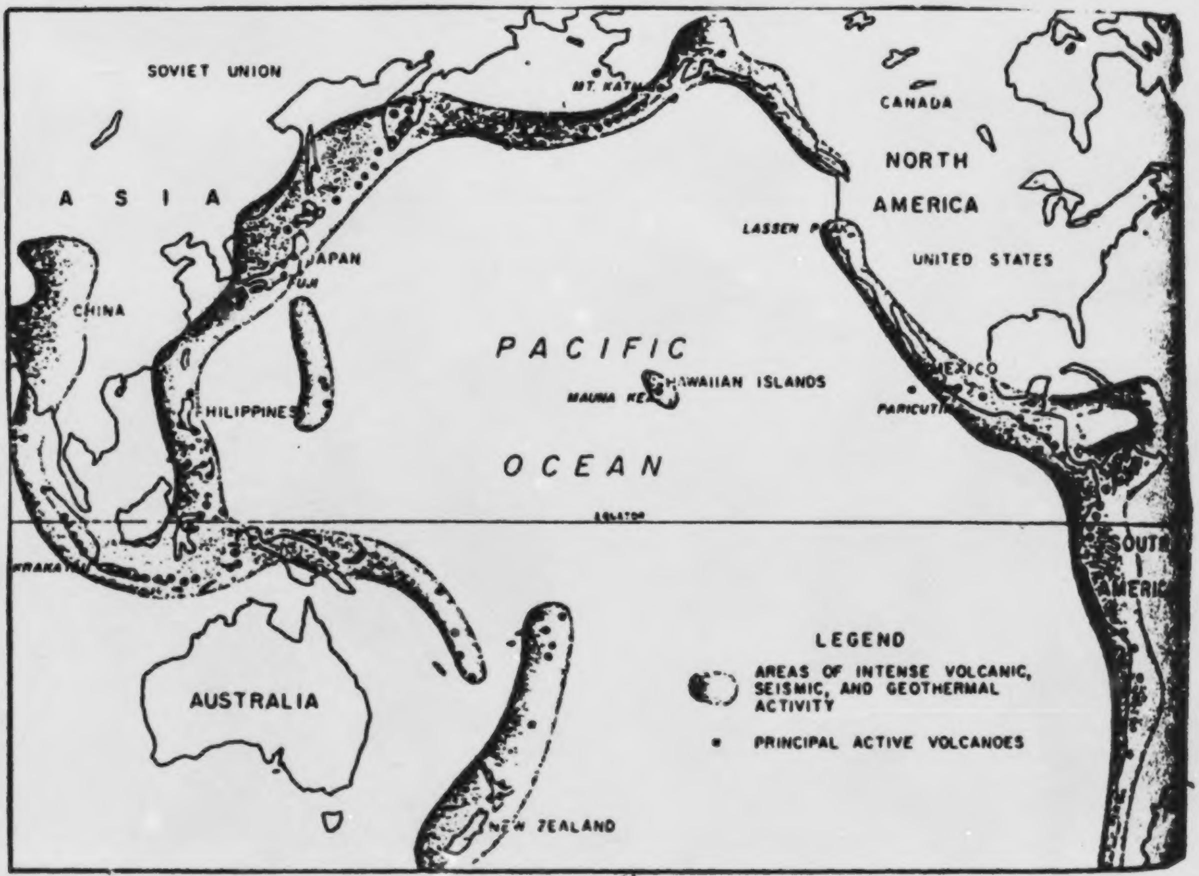
Student Worksheet

MAKE A MODEL VOLCANO



Set a metal funnel upside down in a deep container that is one-quarter full of water. (A coffee percolator pipe also may be used.) Build a slope of modeling clay around the funnel, to the edge of the pan, but just below the rim, to allow space for water. Set the pan on a ring stand and heat it with a Bunsen burner.

1. What happens?
2. How is this model like a volcano or a geyser?
3. What happens at great depths below the earth's surface where no openings are present?
4. What are the possible effects of heating rock, or the fluids within the rock, so that melting occurs or steam forms?
5. What is the relationship between the volcanoes on the map below and the experiment you just did?


SOVIET UNION
MT. KATM
CANADA
NORTH AMERICA
A S I A
LASSEN P
UNITED STATES
JAPAN
FUJI
CHINA
PACIFIC
OCEAN
HAWAIIAN ISLANDS
MAUNA KE
MEXICO
PARICUTI
PHILIPPINES
EQUATOR
KRAKATAU
SOUTH AMERICA
AUSTRALIA
NEW ZEALAND
LEGEND
AREAS OF INTENSE VOLCANIC, SEISMIC, AND GEOTHERMAL ACTIVITY
PRINCIPAL ACTIVE VOLCANOES

"PACIFIC RING OF FIRE"

Student Worksheet

MAKE A MODEL VOLCANO
ANSWER SHEET

1. Steam rises, clay rises, water bubbles up.
2. Pressure builds up in the form of hot water and steam. The pressure escapes through the hole.
3. Large amounts of pressure build up, melting might occur, the fluid matter will travel searching for an opening.
4. Earthquake; geyser or volcano formation.
5. Both powered by the same source.

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Student Worksheet

GEOTHERMAL WELLS

Sources:

Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

Pennsylvania's Energy Curriculum for the Middle Grades. Pennsylvania Department of Education: Harrisburg. 1977.

Geothermal energy is the product of heat radiated from the earth's interior which accumulates below the earth's surface in the form of hot rocks, hot water, or steam. This internal energy of the earth is thought to be the result of the natural decay of radioactive materials. The heat energy may remain trapped in hot rocks or be transferred to underground waterand form hot water or steam. Natural crevices such as hot springs or geysers, or drilled geothermal wells can bring this hot water or steam to the surface, where it can become a source of energy in selected local areas.

There are several types of geothermal wells; the type utilized depending on the type of geothermal deposit present.

DRY STEAM

One well type uses a rare natural phenomenon called "dry steam." This is produced when hot water boils in an underground reservoir. Some of the resulting steam condenses on the surrounding rock, and the rest reaches the surface. Dry steam can be used in a turbine without the need for a boiler. This method is being used by the Geysers Fields power plant in California.

A dry steam plant costs less to build and is cheaper to operate than either a fossil fuel or nuclear fission plant. A typical dry geothermal plant can be placed into operation in about 3 years, compared with about 5 - 10 years for a fossil fuel plant and 10 - 12 for a nuclear fission plant. Unfortunately, the dry steam variety of geothermal energy - although the best understood and the most utilized - is the most limited. Another problem with dry steam is that pollution is created when minerals such as sulfur are released with the steam.

WET STEAM

"Wet Steam" is created when underground water is heated by surrounding rock to the boiling point, but remains liquid because of high underground pressure. This water flows to the surface when wells are drilled in the right places, in a mixture that is 10 - 20 percent steam and the rest hot water. A well-known example is the geysers at Yellowstone National Park. Power production is complicated with wet steam because the steam must first be separated from the hot water before it can be used to run a turbine.

Wet steam is now being used to generate electricity in New Zealand, Japan, Iceland, Mexico and the Soviet Union. Reservoirs have been identified in the United States, chiefly in the western part of the country. The effort to tap these resources is in its earliest stage. As energy prices rise there is in-

STUDENT BACKGROUND INFORMATION
GEOTHERMAL WELLS
(Continued)

creased interest in utilizing lower-temperature, wet geothermal deposits in other parts of the United States, such as south Arkansas. The hot brines in some of the southern Arkansas oil fields represent a commercial potential source of geothermal energy.

GEOPRESSUREIZED SYSTEMS

A third form of geothermal energy is "geopressurized systems," reservoirs of water trapped far underground at high pressures, usually mixed with natural gas. Petroleum exploration has discovered a number of such reservoirs in a belt running 750 miles along the Gulf Coast. There is hope for quick commerical use of these reservoirs, but there is a lack of knowledge about them, especially insofar as how long the high pressure will last. Thus there could be reluctance to invest large amounts of money in the deep drilling needed to reach the geopressurized systems.

HOT, DRY ROCK

The fourth and most common form of geothermal energy is hot, dry rock, which is found near the surface in large areas of the world, including a substantial portion of the western part of the United States. The potential energy of the western states' hot rock areas is very large, but use of this energy depends on both an increase in knowledge about this resource and major advances in technology. To tap these resources, it is proposed to drill a hole deep into the rock formations, fracture the rock either by explosives or hydraulically, pump water down and withdraw the heated water through another hole, extracting the heat to generate electricity. If this approach should become economically feasible, the potential for geothermal energy, including that in Arkansas, would be greatly expanded. In a large part of the Ouachita Mountains of west central Arkansas, large heat sources occur relatively close to the surface.

The speed with which geothermal resources are brought into use obviously depends on a number of economic and technical factors. The best estimate is that the nation's geothermal resources will be supplying only a small part of the nation's energy needs by the year 2000.

Student Worksheet

GEOTHERMAL WELLS

Complete the following chart:

Type of Geothermal Well	Advantages	Disadvantages	Locations

Which type of well do you feel offers the most future promise? ________________
Why?

Which type(s) has potential in the near future for Arkansas?

Student Worksheet

GEOTHERMAL WELLS
ANSWER SHEET

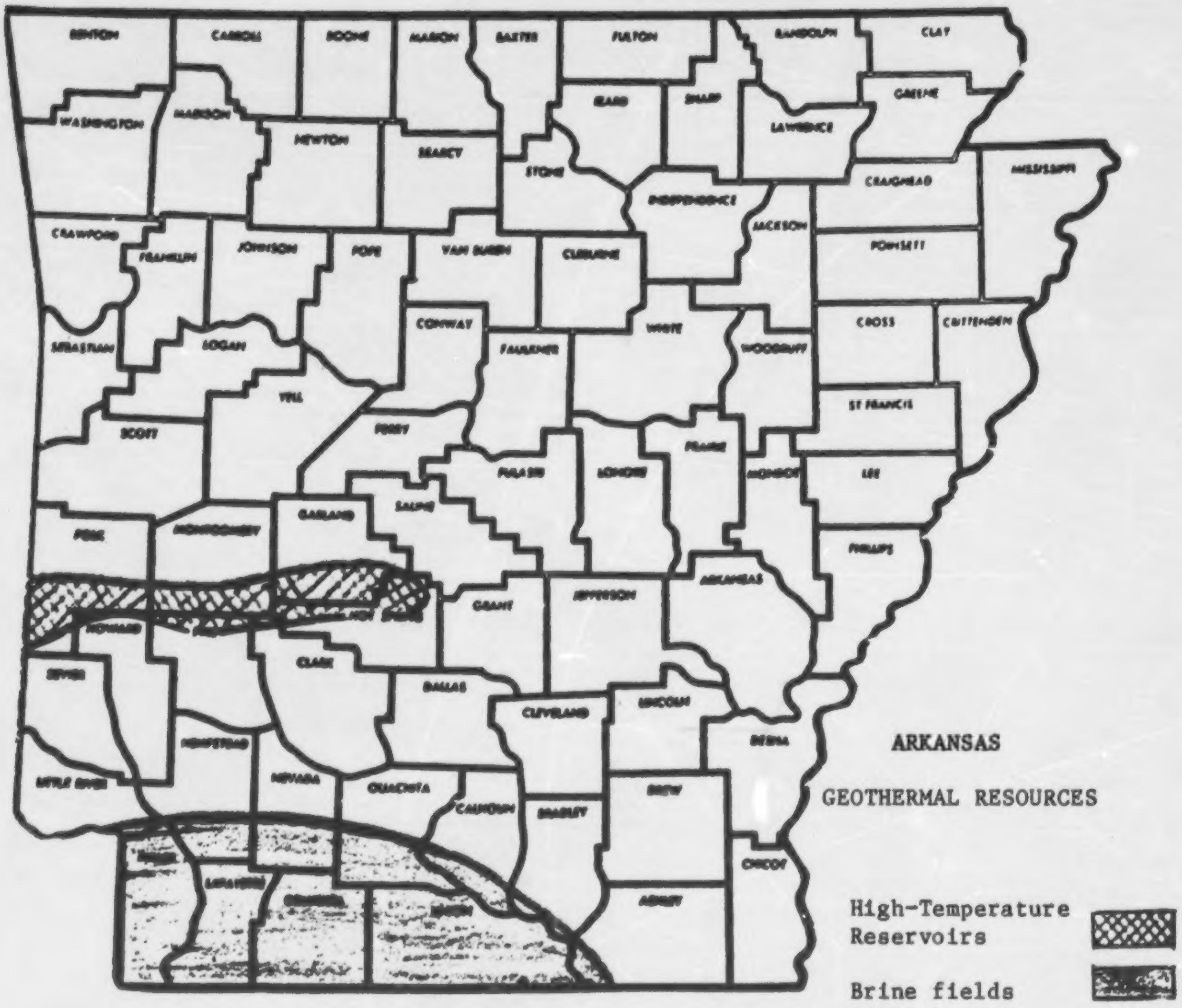
Type of Geothermal Well	Advantages	Disadvantages	Locations
Dry Steam	Most easily usable; no need for a boiler.	Least available. Pollution created when minerals are released	California, Italy, Japan
Wet Steam	Large number of reservoirs.	Steam and hot water must be separated.	Western United States, Iceland, Japan, Mexico, New Zealand, Soviet Union.
Geopressurized system	Large reservoirs. Can be located during petroleum explorations. Possible quick commercial use.	Lack of knowledge, especially how long the pressure will last. Large amounts of money necessary for deep drilling.	Gulf Coast of United States.
Hot, dry rock	Most common. Near the surface. Many locations. Large energy potential.	Need increased knowledge and technology.	Western United States and other areas of the world.

Answer varies.

Hot dry rock and wet steam have Arkansas potential.

Student Worksheet

GEOTHERMAL RESOURCES IN ARKANSAS


BENTON
CARROLL
BOONE
MARION
BAXTER
FULTON
RANDOLPH
CLAY
WASHINGTON
MADISON
NEWTON
SEARCY
IZARD
SHARP
LAWRENCE
GREENE
STONE
INDEPENDENCE
CRAIGHEAD
MISSISSIPPI
CRAWFORD
FRANKLIN
JOHNSON
POPE
VAN BUREN
CLEBURNE
JACKSON
POINSETT
SEBASTIAN
LOGAN
CONWAY
FAULKNER
WHITE
WOODRUFF
CROSS
CRITTENDEN
YELL
SCOTT
PERRY
ST FRANCIS
PULASKI
LONOKE
PRAIRIE
MONROE
LEE
SALINE
GARLAND
POLK
MONTGOMERY
PHILLIPS
ARKANSAS
JEFFERSON
GRANT
HOT SPRING
HOWARD
CLARK
SEVIER
DALLAS
CLEVELAND
LINCOLN
DESHA
HEMPSTEAD
NEVADA
OUACHITA
CALHOUN
BRADLEY
DREW
LITTLE RIVER
LAFAYETTE
COLUMBIA
UNION
CHICOT
ASHLEY
ARKANSAS
GEOTHERMAL RESOURCES
High-Temperature Reservoirs
Brine fields

ANSWER THE FOLLOWING QUESTIONS:

1. In what area(s) of Arkansas is there potential for geothermal energy?
2. Explain the difference in a high temperature reservoir and a brine field.
3. Which of the two in question #2 offers the most for Arkansas at the moment?
4. Which of the two in Question #2 is more easily tapped and economically feasible?
5. If your county is in this area, what evidences of geothermal activity have you noticed?

6. What other areas of Arkansas might you expect to have geothermal potential?
   Why?

Student Worksheet

GEOTHERMAL RESOURCES IN ARKANSAS
ANSWER SHEET

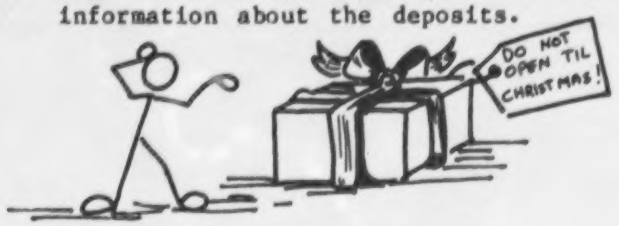
1. Southwest Arkansas.
2. A high temperature field is one in which large quantitites of hot, dry steam is formed. A brine field is one in which steam mixed with hot, salt water is formed.
3. Brine field.
4. Brine field.
5. Answer varies.
6. Answer varies.

Student Worksheet

GEOTHERMAL LIMITS IN ARKANSAS

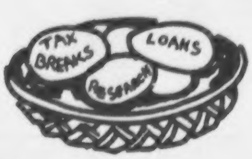
So far, geothermal resources in Arkansas remain almost completely undeveloped for several reasons.

1. There is a scarcity of information about the deposits.


DO NOT OPEN TIL CHRISTMAS!

3. There is opposition to locating power plants in the scenic beauty and prime recreation areas of the Ouachitas.

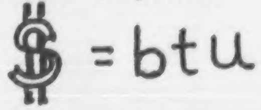
5. More incentives are needed to attract investors and developers.



7. Most of the high temperature deposits are located on federally-owned lands.

NATIONAL PARK

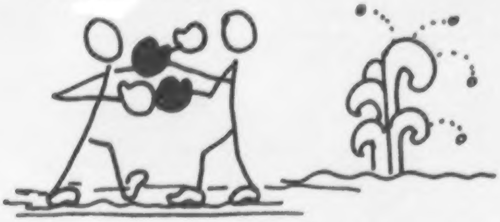
9. Geothermal offers low net energy yield in comparison to the high cost of development.



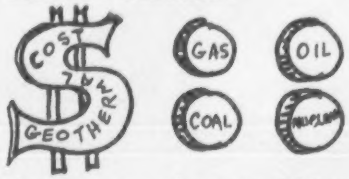
2. Most of the high temperature resources are located in the relatively remote Ouachitas, away from population-industrial centers.

4. Improvements are needed in drilling technologies and equipment.

6. Legal problems, such as ownership and leasing rights need to be clarified.



8. The geothermal market price is not yet competitive with cheaper oil, natural gas, coal, and nuclear fission.



Although geothermal's potential contribution may be large, the stumbling blocks to its development are also large. Geothermal energy is not expected to play a major role in Arkansas' foreseeable energy future.

LESSON #21

CATEGORY: Sources

ENERGY TYPE: Hydropower

TITLE: Hydropower: Harnessing the Energy of Falling Water

GRADE LEVEL: 8-10

INFUSE WITH SUBJECT AREA:
Science
Social Studies
Math

TIME NEEDED: Three periods

MATERIALS:
Terrarium
Optional:
Models of early hydropower uses
Almanacs or streamflow charts

OBJECTIVES:

1. The students will understand the basic concepts of hydropower.
2. The students will realize some advantages and disadvantages of hydroelectric power.
3. The students will become aware of some trade-offs involved in having hydroelectric power plants.

TASK ANALYSIS:

The students should be able to do basic math computations; and be able to read and interpret maps.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 21.4 - 21.9
   Read Teacher Background Information (21.3).
   Gather above-listed materials.

2. Steps in Lesson
   Objective #1: The students will understand the basic concepts of hydropower.
   a. Inform the students that people have used water as an energy source for thousands of years; then ask them to name some primitive ways of using water to get energy. List these ways on the chalkboard.
   b. Use a terrarium to demonstrate the water cycle. Place the terrarium in a sunny spot. Ask the students:
      -What are the drops of moisture that appear on the top and sides of the terrarium? (Water).
      -What causes these drops to form? (The sun).
      -What is the energy source that powers the natural water cycle? (Sun).
   c. Hand out Student Worksheet 21.4. Have the students answer the questions individually, then discuss the answers as a class.
   d. (Optional). Using almanacs or streamflow charts from the United States Corps of Engineers or data from local weather bureaus, have

students graph the annual discharge rate of the stream closest to you. Ask the students whether their data suggest that falling water is a constant or a changing source. (Changing).

Objective #2: The students will realize some advantages and disadvantages of hydroelectric power.

a. Hand out Student Worksheets 21.5 - 21.7. Discuss the information in class, then have the students individually answer the questions. Discuss the answers as a group.
b. If you wish, share the information on Teacher Background Information (21.3) with the class.

Objective #3: The students will become aware of some trade-offs involved in having hydroelectric power plants.

a. Hand out Student Worksheets 21.8 - 21.9. Have the students work in small groups to complete the activities and questions.
b. If possible, visit one of Arkansas' hydroelectric dams (in person or by slides or pictures). Have the students compare the river's system: as it was before the dam was built to present conditions. Have them clarify trade-offs made consciously and unconsciously by the decision to build the dam.
c. Ask the students the following questions about the hydroelectric plant:
   -Why was the plant built in this location?
   -Could it have been built at a different location? Why or why not?
   -Where does the turbine obtain its power?
   -How is the local environment affected by the plant?
   -How is the total Arkansas environment affected by the plant?

3. Evaluation

Check answers to student worksheets for added knowledge.
Have the students write a short paper setting forth the advantages and disadvantages of hydropower.
A written test may be constructed over the material covered.

4. Follow-Up Activities

Have the students collect and display pictures showing how man upset the natural systems in nearby communities.
Make a bulletin board showing:
a. Arkansas hydroelectric power plants.
b. The hydrologic (water) cycle.
c. Natural sites, in Arkansas; that would be suitable or unsuitable for hydroelectric power plants.

TEACHER BACKGROUND INFORMATION

ADVANTAGES AND DISADVANTAGES OF HYDROELECTRIC POWER

Source:

Harry O. Walker. Energy: Options and Issues. University of California: Davis. 1977.

Supporters of hydroelectric units include the following as significant advantages:

1. Relatively low total environmental impact.
2. Extremely high overall efficiency (40 percent for conventional plants).
3. Low operation and maintenance requirements.
4. Nonconsumptive in terms of resources; with the exception of pumped storage units, no external energy is required.
5. Long periods of high productivity.
6. High net energy yield.
7. Easily adapted for automatic operation and control.
8. Quick "startup" time required; peak loads quickly accepted.
9. Multiple use capabilities, i.e., water storage, flood control, navigation, recreation and electric generation.

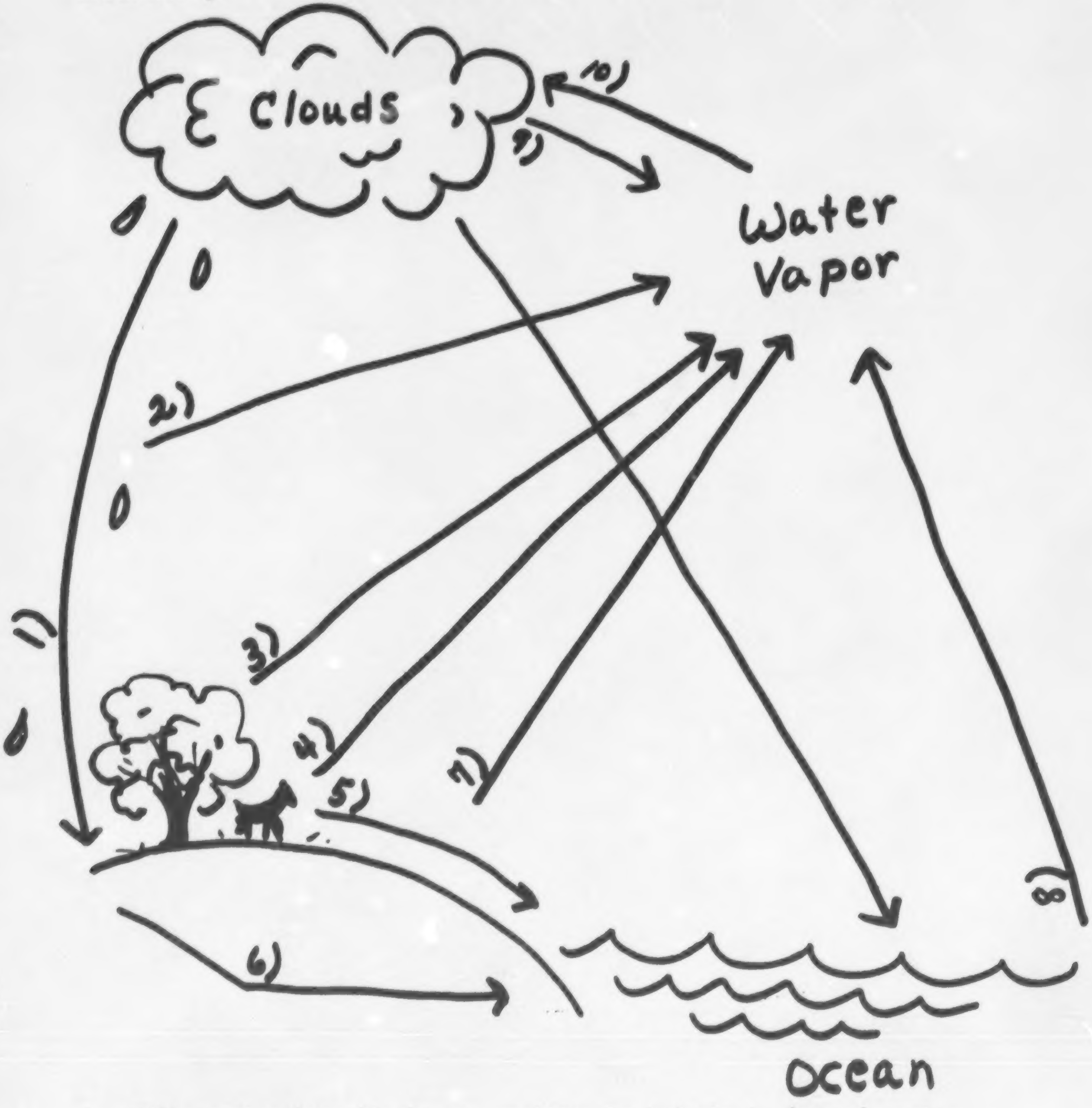
Disadvantages associated with hydroelectric facilities include the following:

1. Limited siting opportunities; must be built where the resource occurs.
2. Interruption of natural stream flow characteristics.
3. Alteration of the habitat for both aquatic and terrestrial organisms.
4. Area inundation and subsequent loss of productive acreage.
5. Disruption of wildlife migration.
6. Distance from load centers forces higher transmission costs and line losses.
7. Destroys forest areas and scenic beauty.
8. Interruptions or reductions in generation when water flow is insufficient.
9. Relatively high construction costs.
10. Limited lifetimes; reservoirs fill up with silt.

Student Worksheet

THE WATER CYCLE

Warmth from the sun evaporates water, which rises to the atmosphere. There it condenses and falls again to the earth as rain. Water that collects in streams can be made to pass through turbines which spin generators to produce electricity.



1. Fill in the above blanks to complete the hydrologic (water) cycle.
2. Why is it called a "cycle?"
3. What is the power source that runs this cycle?
4. Relate this worksheet to a terrarium.
5. How can man make use of this cycle as a source of energy?

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Student Worksheet

THE WATER CYCLE
ANSWER SHEET

1. The water cycle:
    1. Precipitation
    2. Evaporation
    3. Transpiration
    4. Respiration
    5. Run-off
    6. Infiltration
    7. Evaporation
    8. Evaporation
    9. Evaporation
    10. Condensation

2. Water circulates from ocean to atmosphere to land and back to ocean.

3. The sun.

4. Similar cycle; scales differ.

5. Water that collects in streams can be made to pass through turbines which spin generators to produce electricity.

Student Worksheet

HYDROELECTRIC POWER

Source:

Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

Hydroelectric power plants are highly efficient (40 percent overall) and have a high net useful energy yield. Hydroelectric plants do not significantly consume water, heat the water of streams, or contribute to air pollution. After using its motive force, the water is returned unharmed to the stream to perform other tasks downstream.

These favorable characteristics, combined with increasing shortfalls and costs of oil and natural gas, make hydroelectric power an increasingly attractive choice as a source of electric power generation. In addition to generating electricity, many hydropower projects serve one or more other beneficial purposes such as flood control, navigation, irrigation or recreation.

NO THERMAL POLLUTION FROM THIS POWER PLANT!

The large scale development of hydroelectric power is limited by the availability of suitable sites. A favorable site has a high "head" (height of falling water), a high rate of water flow, a large water storage capacity (reservoir) and nearness to a population center.

Hydroelectricity is not without drawbacks. Large-scale hydroelectric installations harm the surrounding environment by lowering water levels below the dam, and by submerging farmland, wildlife habitats, mineral deposits, timber, scenic free-flowing streams, and historical and archaeological sites above dam. The electric transmission lines and towers emanating from the power plant tend to degrade the environment. Although operating costs are relatively low for a hydroelectric plant, construction costs can be very high, depending on size, land costs, and the expenses of relocating people and facilities flooded out by the reservoirs.

Hydropower generation is vulnerable to the whims of nature. Any sustained period of rainless weather can reduce the generating capacity.

Although water power is usually classified as a renewable resource, all hydroelectric power dams have finite lives ranging from 50 to 300 years, because the reservoirs eventually fill up with silt.

Student Worksheet

HYDROELECTRIC POWER
(Continued)

Low-head hydroelectric power, which is power from dams less than 65 feet high, has generally been ignored in the United States since the turn of the century. Low-head hydropower plants are small scale, and serve individuals, small communities, and farms. Even very small streams can be harnessed to produce electricity. The potential for small-scale water power systems has been overshadowed by interest in large hydroelectric installations. But conditions are changing. American energy experts are taking a second look at the thousands of small, non-power-producing dams, many in Arkansas, that dot the landscape -- mill dams, flood control dams, municipal reservoir dams. Collectivley, these dams could make a significant contribution to power production. There are also many sites where low-head dams could be built without the controversy that so often accompanies high-dam projects. Someone has quipped: "Low-head hydro is an obsolete technology whose time has not yet come."

The United States Department of Energy is sponsoring research and demonstrations of new and innovative methods to take advantage of low-head hydro. This work includes evaluation of new equipment, standardization of power plant designs, feasibility studies for installation of low-head dams at specific sites and demonstrations of available technology.

As always, there are some problems in harnessing existing small dams for hydropower. Many are located on streams that dry up for part of most years. Silting may have reduced their reservoir capacities. Owners may block their use. And American industry is geared to produce only large-scale hydroelectric machinery.

Converting existing dams, such as those on the Arkansas River and the many abandoned or underused low-head dams, to the additional purpose of producing electricity makes sense, if technically and economically feasible. The structures and reservoirs are already in place, lacking only the facilities for generating electricity. But building new dams on Arkansas streams to produce electricity does not seem prudent. Arkansas' remaining undammed streams, especially those in the Ozarks and Ouachitas, are far more valuable for recreation and ecological balance than for the modest amounts of electricity they might provide.

Student Worksheet

HYDROELECTRIC POWER
(Continued)

Answer the following questions:

1. List two aspects of hydroelectric power that will make it protective of the environment.

2. List two aspects of hydroelectric power that will make it a detriment to the environment.

3. List two aspects of hydroelectric power that will aid in conservation.

4. List two ways the environment can be detrimental to hydroelectric power plants.

5. Identify an economic barrier to hydroelectric power plants.

6. Comment on the efficiency of hydroelectric power.

7. Would you want to live near a hydroelectric power plant?
Why or why not?

8. What outside influence makes hydroelectric power seem more attractive?

9. Comment on the aesthetic effects of a hydroelectric complex.

Student Worksheet

HYDROELECTRIC POWER
ANSWER SHEET

1. Does not significantly consume water, heat the water of streams, or contribute to air pollution.
2. Lower water levels, submerge land and habitat, dam streams, destroy scenic beauty.
3. Water is returned unharmed to the stream to perform other tasks downstream; hydroelectric projects serve more than one purpose.
4. Rainless weather can reduce generating capacity; reservoirs eventually fill up with silt.
5. High construction costs.
6. High net useful energy yield.
7. Answers vary.
8. Increasing shortfalls and cost of oil and natural gas.
9. Answers vary.

Student Worksheet

MAJOR ARKANSAS ELECTRIC POWER PLANTS
(Major: 25 + Megawatts per Day)

Plant Name	Location/County	Owner	Generating (Capacity)	Fuel Type
Arkansas Nuclear One	Pope	APL	1748	Nuclear
Robert E. Ritchie	Phillips	APL	900	Oil/Natural Gas
Lake Catherine	Hot Spring	APL	756	Oil/Natural Gas
Flint Creek	Benton	SWEPCO/AECC	528	Coal
Bull Shoals	Baxter-Marion	CE	340	Hydro
Cecil Lynch	Pulaski	APL	245	Oil/Natural Gas
Harvey Couch	Lafayette	APL	161	Oil/Natural Gas
Hamilton Moses	St. Francis	APL	144	Oil/Natural Gas
John McClellan	Ouachita	AECC	134	Oil/Natural Gas
Dardanelle	Pope-Yell	CE	124	Hydro
Carl E. Bailey	Woodruff	AECC	122	Oil/Natural Gas
Beaver	Carroll	CE	112	Hydro
Ozark	Franklin	CE	100	Hydro
Greers Ferry	Cleburne	CE	96	Hydro
Blakely Mountain	Garland	CE	75	Hydro
Mabelvale	Pulaski	APL	73	Oil/Natural Gas
Norfork	Baxter	CE	70	Hydro
DeGray	Clark	CE	68	Hydro
Carpenter	Garland	APL	59	Hydro
Thomas B. Fitzhugh	Franklin	AECC	59	Oil/Natural Gas
Crossett	Ashley	GP	45	Oil/Natural Gas
Blytheville	Mississippi	ARKMO	33	Oil/Natural Gas
City Light	Craighead	CWL	29	Oil/Natural Gas
Narrows	Pike	CE	26	Hydro
White Bluff	Jefferson	APL/AECC CWL	1400	Coal
			7447 Total	

Key to Owners:

AECC: Arkansas Electric Cooperative Corp.
APL: Arkansas Power and Light Co.
ARKMO: Arkansas-Missouri Power Co.
CE: U.S. Army Corps of Engineers
CWL: Jonesboro City Water & Light
GP: Georgia Pacific Corp.
SWEPCO: Southwestern Electric Power Co.

Student Worksheet

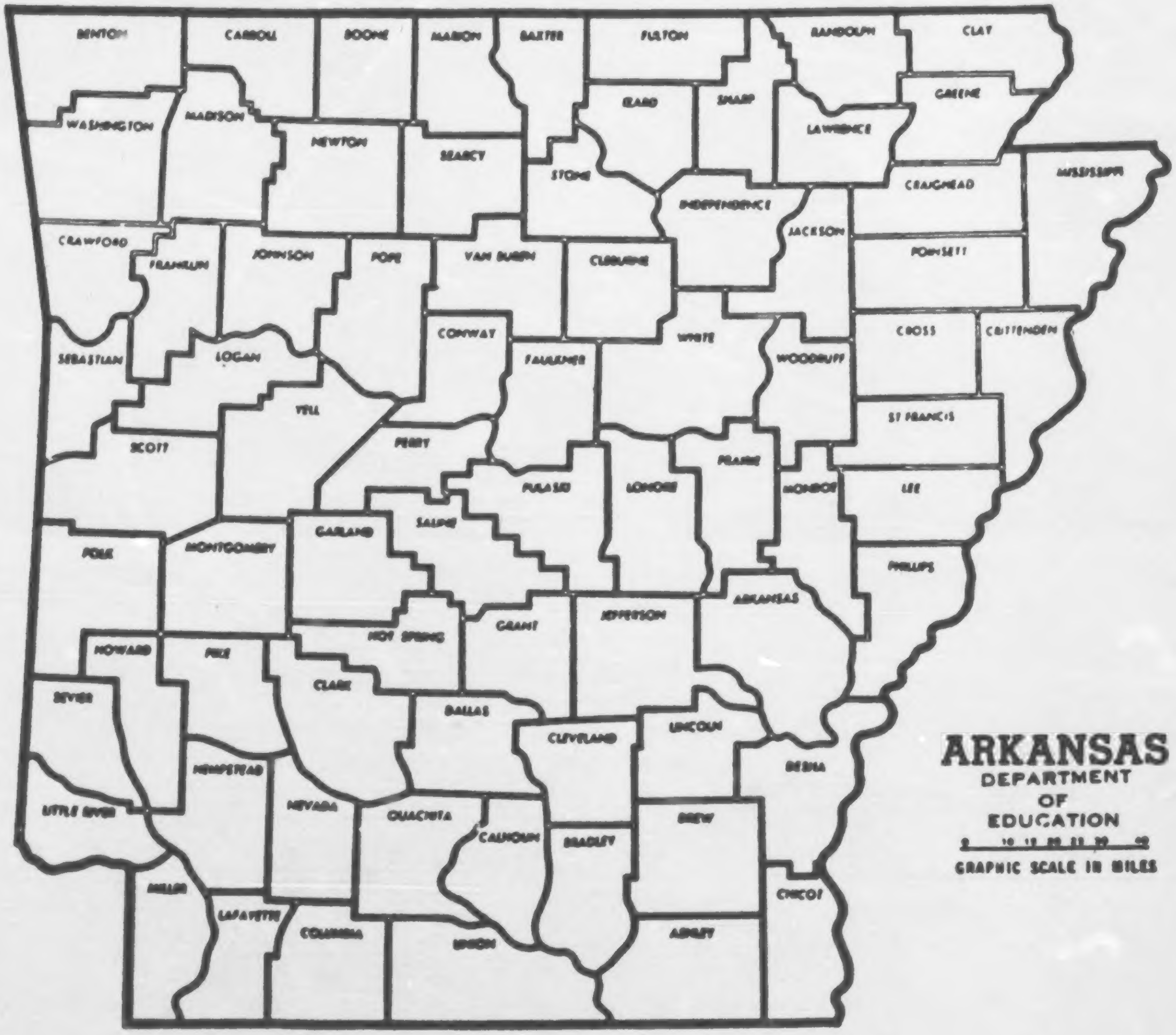
ARKANSAS HYDROPOWER

Answer the following questions (Based on Student Worksheet 21.8):

1. Underline the hydroelectric power plants located in Arkansas.
2. What agency controls most of Arkansas' hydroelectric power plants?
3. Do you feel that it would be wise for any one agency to have a monopoly over the state's hydroelectric plants?
   Why or why not?
4. What is the total generating capacity of Arkansas' hydroelectric plants?
5. What proportion is this of Arkansas' total electrical generating capacity?
6. Which hydroelectric plant generates the most electricity? The least? How would you explain this difference in generating capacity?
7. Are there any potential low-head hydropower sites in your vicinity?

Use the map below to do the following activities:

1. Plot the location, by county, of the hydroelectric plants in Arkansas.
2. Explain any pattern you observe.


BENTON
CARROLL
BOONE
MARION
BAXTER
FULTON
RANDOLPH
CLAY
WASHINGTON
MADISON
NEWTON
SEARCY
IZARD
SHARP
LAWRENCE
GREENE
STONE
CRAIGHEAD
MISSISSIPPI
INDEPENDENCE
JACKSON
CRAWFORD
FRANKLIN
JOHNSON
POPE
VAN BUREN
CLEBURNE
POINSETT
CONWAY
WHITE
CROSS
CRITTENDEN
SEBASTIAN
LOGAN
FAULKNER
WOODRUFF
YELL
ST FRANCIS
SCOTT
PERRY
PRAIRIE
PULASKI
LONOKE
MONROE
LEE
GARLAND
SALINE
POLK
MONTGOMERY
PHILLIPS
ARKANSAS
JEFFERSON
HOT SPRING
GRANT
HOWARD
PIKE
CLARK
SEVIER
DALLAS
LINCOLN
CLEVELAND
DESHA
HEMPSTEAD
LITTLE RIVER
NEVADA
OUACHITA
CALHOUN
BRADLEY
DREW
MILLER
CHICOT
LAFAYETTE
COLUMBIA
UNION
ASHLEY
ARKANSAS
DEPARTMENT
OF
EDUCATION
GRAPHIC SCALE IN MILES

Student Worksheet

ARKANSAS HYDROPOWER
ANSWER SHEET

1. Bull Shoals, Dardanelle, Beaver, Ozark, Greers Ferry, Blakely Mountain, Norfork, DeGray, Carpenter, Narrows.
2. Corps of Engineers is the main agency. Arkansas Power and Light is a lesser agency.
3. Answers vary.
4. 1070 megawatts.
5. 14 percent.
6. Bull Shoals (most)
   Narrows (least)
   Bull Shoals is the larger powerplant.
7. Answers vary.

Map Activities:

1. Baxter, Marion, Pope, Yell, Carroll, Franklin, Cleburne, Garland, Clark, Pike.
2. Most of the hydroelectric facilities are located in northwest Arkansas, where the more suitable (fast flow, high fall) sites occur. A few are located in the middle and southwest.

279

LESSON #22

CATEGORY: Sources

ENERGY TYPE: Wind

TITLE: Wind Power: It's a Real Blow!

GRADE LEVEL: 7-10

SUBJECT AREA:
Science
Industrial Arts
Social Studies

TIME NEEDED: Two-Five periods

MATERIALS:

1 transparent plastic soda straw
1 single edge razor blade
1 styrofoam ball to fit inside straw
3 pieces stiff, corrugated cardboard 5 cm wide
2 straight pins
Marble-size lump of modeling clay
2 rubber pencil erasers
Tape
1 old bicycle wheel
1 fork of frame that holds bicycle wheel
1 pipe or post - 5 feet tall
15 pieces of metal sheeting - 12 inches x 8 inches
1 drill and 2 rivets/2 nuts and bolts or 1 soldering iron
2 flat strips of metal 3/16 inch thick

OBJECTIVES:

1. The students will discover the relationship between solar energy and moving air.
2. The students will become familiar with some past uses of wind.
3. The students will determine the feasibility of wind as a future energy source.
4. The students will express their feelings about the aesthetic implications of wind machines.

TASK ANALYSIS:

The students should be able to follow instructions for constructing apparatus; and be able to read material, then answer questions about that material.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 22.5 - 22.10.
   Gather above-listed materials.

2. Steps in Lesson
   Objective #1: The students will discover the relationship between solar energy and moving air.

   a. Have the students complete the following sentence: "Wind is ________________." Write the words contributed on the chalkboard, no matter how unlikely they may sound to you.

From this list of words, have the students develop a list of opposite words which can be used to describe moving air. (Hot-cold, good-bad, fickle-steady, reliable-unpredictable, gentle-violent, etc.).

Ask: "What do most of the words tell us about what wind is? (Moving air).

b. The following information can be shared with the students:
Wind is an indirect form of solar energy that can be converted by wind turbines to mechanical energy and to electricity. Wind is caused by the uneven heating and cooling of the earth's surface. As the land warms, the air above it is also warmed. Warm air rises and cooler air rushes in at the surface to take its place, resulting in anything from a gentle breeze to a roaring gale.

c. Ask the class if there is anyone who has experienced a hurricane or severe storm. If so, ask them to describe the storm, emphasizing the force of the wind, the pressure it exerts, the work it can do. Have the class collect pictures and news accounts of tornadoes that have passed over Arkansas; then make a bulletin board display.

d. Have the students research and report to the class on the classification of winds by the United States Weather Service. Have the students distinguish between energy winds and prevalent winds. (Prevalent winds: common, up to 5 days a week, 5 - 15 miles per hour; energy winds: storm winds, average 2 days per week, 10 - 25 miles per hour; for example, the "Northeaster" or "Southwester").

e. (Optional). Hand out Student Worksheet 22.5. Do this activity as a teacher demonstration, group projects or individual projects. If more than one windmill is constructed, they may be mounted at different points about the school campus.

Objective #2: The students will become familiar with some past uses of wind.

a. Have the students brainstorm as many ways as possible that wind has been used, writing them on the chalkboard as they call them out.

b. The following information may be shared with the class:
Since the beginning of recorded history people have used the wind to move ships on the sea and power windmills. For centuries windmills have ground grain into feed and flour and pumped water for irrigation. By the 1920's, wind power had become a major source of electrical power on farms and homesteads across the United States. These small-scale generators served well for years providing cheap, clean electrical power to thousands of rural and farm homes. However, the establishment of the Rural Electrification Administration (REA) in 1930 made federally-subsidized, centrally-generated electrical power available to farms. Installation of all the cables took about twenty years, but by 1950, small-scale windmills were a thing of the past. Today the rapid depletion and spiralling costs of conventional fuels are causing a resurgence of interest in wind energy.

Objective #3: The students will determine the feasibility of wind as a future energy source.

a. Hand out Student Worksheets 22.6 - 22.8. Have the students read the material and answer the questions, then discuss the answers in class.

b. Hand out Student Worksheet 22.9. Construct the wind meters as a class demonstration, group projects or individual projects.

c. Using the wind meters, ask the students to investigate the direction and average speed of the prevailing and energy winds in their area.
   Ask:
   -What would be the most important characteristics to consider in deciding whether to set up a windmill in your area? (Prevailing wind, regularity, best height).
   -Would our area be satisfactory? (Scientists say that winds needed for power production should fall between Beaufort force 3 and 6 (gentle to strong breeze); higher winds may be destructive).

d. (Optional). Hand out Student Worksheet 22.10. Have the students do the activity in small groups, then compare results.

e. Have the students make a model or map of their community showing where they would place windmills to provide the community with the maximum energy which could be derived from wind power. Would this be a good energy source for your area?

Objective #4: The students will express their feelings about the aesthetic implications of wind machines.

a. Have the students collect pictures of as many different types of wind machines as possible. Arrange these pictures in a bulletin board display. Have the students study these pictures, then:
   -Describe what constitutes an objectionable view. Note that what one considers objectionable, another does not.
   -Compare the ecological impact of wind-generated energy with the aesthetic impact caused by the appearance of the wind machines.
   -Discuss the possible appearance of wind machines in the yards of homes. Should wind machines be located in front yards?
   -Have the students express their feelings about the various wind machines. Poetry, song, painting or essay may be used as a medium of expression.

b. Have the students describe four ways wind energy can be used to beautify surroundings, to move water, to support life, etc.

c. Have the students design an aesthetically pleasing wind machine; display the products.

3. Evaluation

Have the students make a chart, mural or set of models showing ways of capturing wind for the energy of its motion.

Have the students write a story about a time when wind failed to act as a renewable resource.

4. Follow-Up activities

Ask: "What is the principal 'fuel' for the earth's heat machine?" (Water vapor in the atmosphere, holding latent energy which is transferred to the atmosphere when water is alternately evaporated and condensed in the water cycle. Wind is the most evident form of this energy).

Have the students investigate:

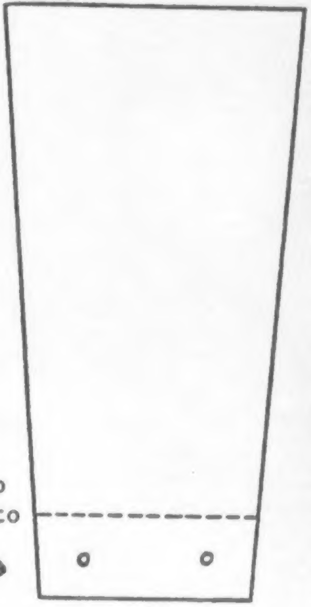
a. The use of sailing ships throughout history.
b. The use of wind to pump water throughout history.
c. How "sails" made windmills more efficient.
d. Uses of wind energy being made today.
e. Unusual uses of wind energy. (The Arkansas Energy Office has helped fund construction of a car converted to run on electrical batteries which are charged by a wind machine; the Japanese shipping fleet is using sails as a supplemental energy source; the United States Department of Energy is planning construction of an experimental wind turbine in Arkansas).

Student Worksheet

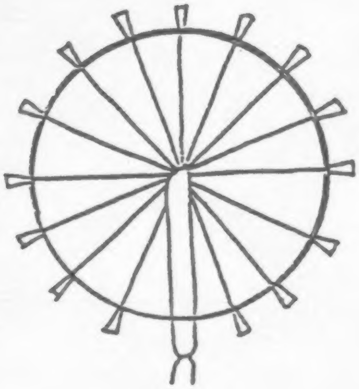
CONSTRUCTING A WINDMILL

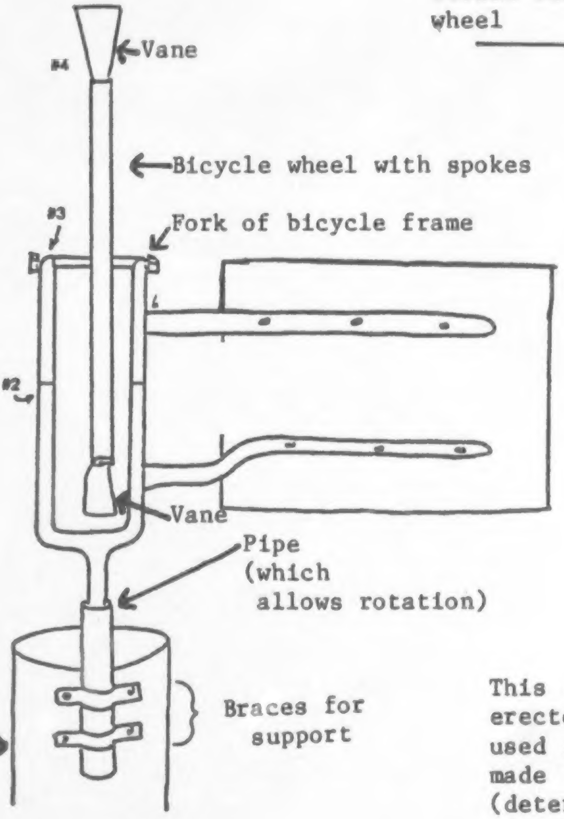
Cut metal sheeting into a 12-inch x 8-inch rectangular shape rounding off the corners. Next cut and extend by a weld or nuts and bolts the frame that holds the wheel in place. Place wheel into grooves so that it may rotate. Now cut metal flaps or blades that will be attached to wheel. Bend and rivet into place. You will need a weld to the frame extending outward (flat strips to frame). Large 12-inch x 8-inch sheet is now attached to metal strips. To mount the windmill a piece of pipe may be attached to a pole and upper end of front wheel brace (fork) lowered into pipe. Windmill should now rotate and turn according to the wind.

Vane
(actual size)


Bend
Holes drill to attach blade to wheel

Side view of windmill




#4
Vane
Bicycle wheel with spokes
#3
Fork of bicycle frame
#2
Vane
Pipe (which allows rotation)
Post, pole, etc., for holding windmill
Braces for support

This model can also be erected and accurately used as part of a homemade weather station (determining both speed and direction of the wind). Efficiency test: try it with vanes mounted between the spokes.

Source: West Virginia Department of Education

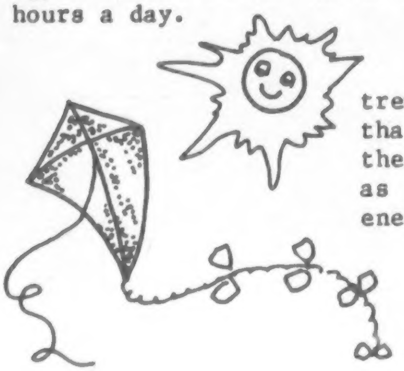
Student Worksheet

WIND ENERGY

Source:

Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

Wind, like coal, wood, and small dams, has been rediscovered. Wind energy, which only a few years ago was considered outmoded, may be on its way back. Wind is an almost inexhaustible, renewable, clean, and safe source of energy that has a moderate net useful energy yield and is based on developed technology. Unlike direct solar energy, wind energy in a windy area can be tapped 24 hours a day.



The total amount of potential energy in the wind is tremendous. About 2 percent of all the solar radiation that falls on the earth is converted to wind energy in the atmosphere. It is theoretically possible to harness as much as 60 percent of this indirect form of solar energy.

WIND ENERGY CONVERSION

WIND ENERGY → **MECHANICAL ENERGY** → **ELECTRICAL ENERGY**

MECHANICAL ENERGY ↓
- Pumping
- Grinding
- Compressing
- Agitating

ELECTRICAL ENERGY ↓
- Lightning
- Electrolysis
- Motors

Even though wind energy has been used for centuries and has been an important energy source in the past, extensive use of wind energy today has been held back by several factors. Inflation has caused the cost of wind machines to soar. At present, wind energy is not economically competitive with conventional energy sources. Wind does not always blow where and when it is desired. The overall wind energy potential in the northern half of Arkansas is considered "fair" by wind energy authorities, and the potential in the southern half of the state is labelled "low."

Hourly observations by the National Weather Service over a period of 10 years have shown Little Rock to have an average wind speed of 8.7 miles per hour. Wind speeds for the United States range from a high in Fargo, North Dakota, of 14.4 miles per hour to a low of 6.8 miles per hour in Los Angeles, California.

Student Worksheet

WIND ENERGY
(Continued)

Accurate wind speed data are needed for a specific site to determine what type and size of wind turbine are feasible. Determining where and when the wind blows is not as simple as it might seem. Wind is a sporadic source of energy, and varies widely over small areas. Most of what is known presently about wind is based on data collected at airports, which were built in precisely those locations where the wind blows the least. Energy storage techniques need to be improved because even windy areas have periods of calm.

One environmental objection to wind power is the visual pollution of turbines dotting the landscape. Although their environmental impact will be small compared with that of most other energy alternatives, wind systems, like direct solar, will require large amounts of materials whose mining, processing, and transportation will affect the environment. Very large turbines may cause noise pollution and interfere with television reception.

Despite its environmental attractiveness as a minimally polluting energy source, wind power probably will not be able to provide a large part of the total Arkansas energy requirements because of its variability. However, wind power could provide supplemental energy for rural homes and agriculture, where it is suitable for providing power for irrigation systems.

Student Worksheet

WIND ENERGY
(Continued)

Answer the following questions:

1. A major deterrent to use of wind power is ______________________________.

2. Wind is a result of ____.

3. Wind can be converted to secondary forms of energy such as ______________________________ and ______________________________.

4. What advantage does wind power have over direct solar power?

5. Describe Arkansas' wind potential.

6. The average windspeed for Little Rock over a 10-year period is ___________. Why examine winds over such a long period of time?

7. Do you think Little Rock's wind speed is typical for the whole state? Why or why not?

8. Why is wind energy storage a necessity?

9. What is visual pollution?

10. Why do wind machines create so much visual pollution?

11. What other type(s) of pollution might be created by wind machines?

12. Wind is a __________________ polluting energy source.

13. Would you like to see Arkansas invest a large of amount of funds in the development of wind energy?
Why or why not?

Student Worksheet

WIND ENERGY
ANSWER SHEET

1. High cost per output; variability; need for improved storage techniques.

2. Imbalances in solar radiation.

3. Mechanical and electrical.

4. Can be used twenty-fours a day.

5. Northern part of the state is "fair," southern part of the state is "low."

6. 8.7 miles per hour
   To obtain an accurate average wind speed.

7. Answers vary.

8. Even windy areas have periods of calm.

9. Offends sight; spoils aesthetic beauty of nature.

10. The wind machines may be very large with long blades and great height; or there may be many small machines dotting the landscape.

11. Noise.

12. Minimally.

13. Answers vary.

Student Worksheet

WIND METER

1. At one end of a straw cut a small notch 1 cm from the end with a razor blade. Be careful not to cut through the straw.

2. At the opposite end, on the same side, make a pinhole .5 cm from the end.

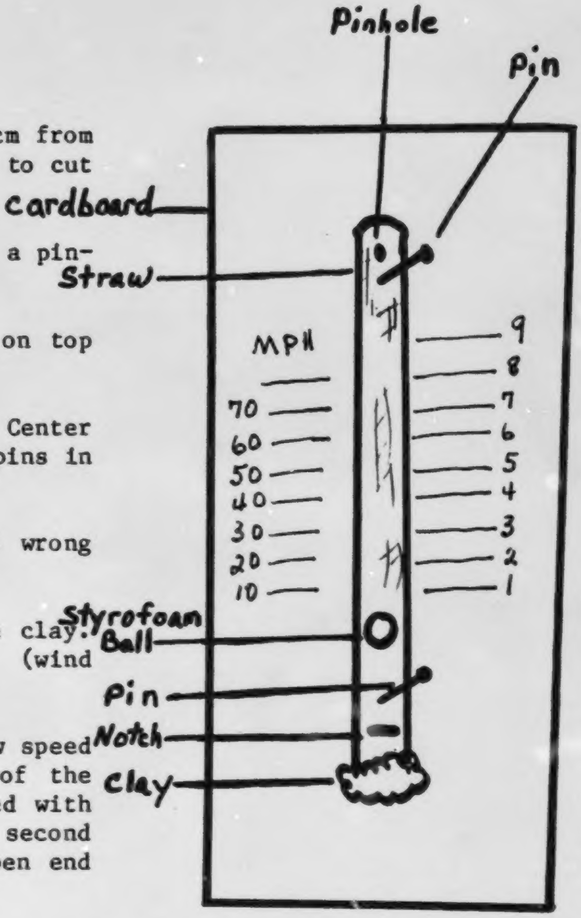
3. Tape three cardboard pieces together, one on top of another to make 3 thicknesses.

4. Place a styrofoam ball inside the straw. Center straw on cardboard with notch up. Put the pins in as indicated. Push pins through.

5. Place erasers on ends of the pins on the wrong side of the cardboard.

6. Plug the notched end of the straw with the clay. This is the bottom of the anemomenter (wind meter).

7. Calibrate the anemometer with 2 scales - low speed and high speed, indicated on either side of the straw. The low speed scale will be measured with the open end of the straw uncovered. The second scale (high speed) will be done with the open end covered.



8. To calibrate the scales, hold the anemometer out the window of a car driven (by a parent) at uniform speeds. The driver should start at 1 mile per hour. The end of the anemometer should be uncovered. Mark the cardboard where the styrofoam ball is. Have the driver proceed at 1 mile per hour intervals. On the other side of the straw, calibrate the high speed scale. Mark the scale on the cardboard at intervals of 10 miles per hour.

9. When the anemometers are completed, go outside to measure wind velocity at various locations around the school. Determine the most likely site for a wind machine.

10. Write statements of conclusions about wind effects. For example:

    a. Higher wind speeds occur at tops of hills.
    b. Wind effects around buildings are most pronounced on the windward side, corners and rooflines.

Source: United States Department of Energy

Student Worksheet

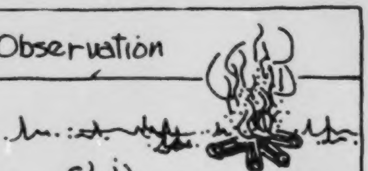
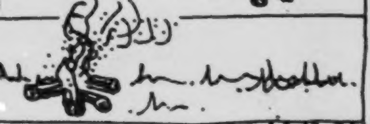
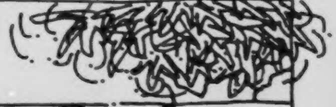
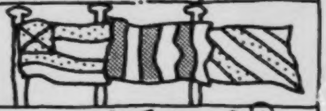
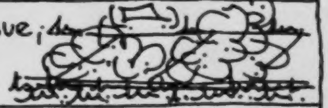
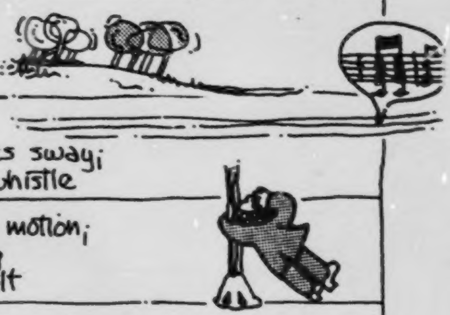
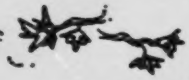
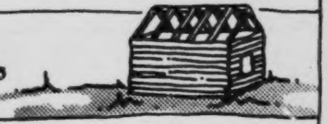
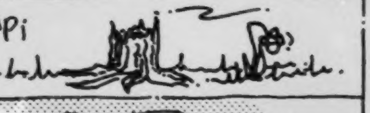
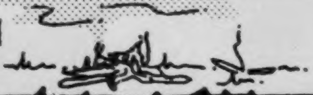
BEAUFORT WIND SCALE

1. Measure the wind with the Beaufort Wind Scale
2. Keep a record of wind speeds at different times of day.
3. At what time of day do the fastest winds usually occur?
4. At what time of day is there enough wind to make electricity where you live?
5. Are the winds in your area steady or gusty?
6. How many hours during the day could a wind generator make electricity based on your observations?

Optional:

7. Can you predict the winds from the clouds or other signs?
8. What kind of clouds are overhead? What wind speeds are associated with different types of clouds?
9. How accurate are your wind predictions, using clouds and other signs?
10. How accurate is the Weather Service in predicting the winds in your area?

* mph = miles per hour

Beaufort number	Description*	Observation
0	calm (0-1 mph)	smoke rises vertically 
1	light air (2-3 mph)	smoke drifts slowly 
2	slight breeze (4-7 mph)	leaves rustle; windvane moves 
3	gentle breeze (8-12 mph)	twigs move; flags extended 
4	moderate breeze (13-18 mph)	branches move; dust and paper rise 
5	fresh breeze (19-24 mph)	small Trees sway 
6	strong breeze (25-31 mph)	large branches sway; wires whistle
7	moderate gale (32-38 mph)	Trees in motion; walking difficult
8	fresh gale (39-46 mph)	twigs break off trees 
9	strong gale (47-54 mph)	branches break; roofs damaged 
10	whole gale (55-63 mph)	Trees snap; damage evident 
11	storm (64-72 mph)	widespread damage 
12	hurricane (73-82 mph)	extreme damage

Source: United States Department of Energy

LESSON #23

CATEGORY: Conservation

ENERGY TYPE: All

TITLE: Nature's Cycles

GRADE LEVEL: 7-9

TIME NEEDED: Three periods

INFUSE WITH SUBJECT AREA:
Science
Social Studies
Art
Math
Health

MATERIALS:
Trash brought by students
1 large jar
Soil to fill jar
Dictionary
Several burners
Several sets of tongs
Several pair of goggles
Fume hood or outside access
Small bag of leaves
1 world map
1 Arkansas map
10 pieces newsprint
1 screen
1 dish - larger than screen
4 pieces blotting paper - screen size
1 bowl
2 cups hot water
2 teaspoons instant starch

OBJECTIVES:

1. The students will understand the meaning of waste and will determine how we dispose of our waste.
2. The students will discover why we have a lot of waste and how waste affects our resources.
3. The students will investigate the meaning of recycling and the savings involved in recycling.
4. The students will investigate attitdues toward recycling and exhibit a willingness to use, in their own lives, the things they have learned about recycling.

TASK ANALYSIS:

The students should be able to use a dictionary; and be able to read and interpret maps.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 23.11 - 23.19.
   Assign students to bring articles of trash.
   Gather above-listed materials.

2. Steps in Lesson

Objective #1: The students will understand the meaning of waste and will determine how we dispose of our waste.

a. Have the students use a dictionary to look up and discuss the cultural origins of the words garbage, trash, junk, refuse, rubbish, scrap. Have them list the words in order of their offensiveness. Ask:
   - -Does this list have any relation to the origin of the word?
   - -What types of waste are produced from an average household?
   - -Which ones are in the greatest quantity?

   A display can be set up illustrating the different types.

b. Have the students identify the types of waste that result from the production, consumption and disposal of a can of beef stew. The main components to be traced are meat, potatoes, tin can, paper label. For example, Meat-grain from the earth, steers eat grain, steers slaughtered, we eat beef. Result-grain waste, manure waste, slaughter waste, sewage waste, table scraps.

c. Discuss the fact that energy is required to make all of the substances we throw away, then energy is required to dispose of this trash. Have the students list substances commonly thrown into trash cans such as paper, food wastes, glass containers, plastic wrapping, etc. Ask students to "guess" what substances comprise the major portions of solid waste found in the "National Trash Can."

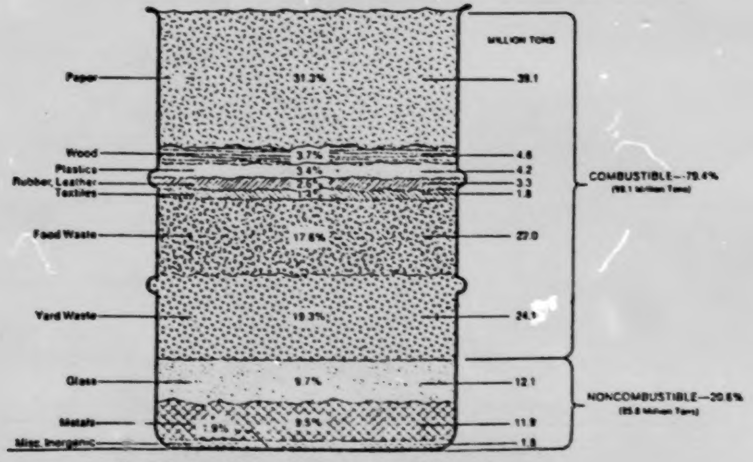
   Present, using an overhead projector, the figure below that shows the amount of various substances comprising the national trash can in 1971. Compare the data shown with their guesses.

   Have students speculate whether the contents of the trash can have changed since 1971. Why or why not?

   Ask students to list several things they or their families can do to reduce waste in some of the categories. Discuss the suggestions.

National Trash Can

(Annual Municipal Solid Waste—1971)



Source—*Environmental Protection Agency, Second Report to Congress, Resource Recovery and Source Reduction, 1974.*

d. Have students look for signs of pollution on the way to and from school. A litter hunt can be held to clean up the school area. Ask:
- What is the most common type of litter?
- Where is the most litter found?
- What is a "litterbug?" Who are the worst litterbugs?
- What is meant by "throwing something away?" Where is away?
- How are waste products disposed of in our society? (Dumping, littering, burning, burying, recycling).
- How does our community dispose of its residential waste?

e. This activity should take place in a laboratory with equipment such as goggles, bunsen burner, tongs and a fume hood. Proper ventilation and safety is stressed, especially for plastics.

Break the class into teams. Give each team 5 - 10 materials to burn; including a variety of household waste-food, metal, plastic, paper, etc. Prepare a data sheet noting the initial weight and residue weight of each item burned, the color of flame and smoke, and the odors produced. Ask:
- What are the components of smoke? Could they be harmful?
- Could the smoke be filtered or cleaned to reduce harm to the environment?
- What are the advantages of burning waste? (Reduction in volume, breakdown of some dangerous chemicals, etc.). Could the heat generated be productively used?
- Does our community burn any of its waste? Does it use effective antipollution control equipment?

f. Create an "open dump" in the classroom. Fill a large jar with moist soil. Add small pieces of: a metal barrette or paper clip, newspaper, plastic, food (apple or orange peel), aluminum foil, etc. Add a little "rain" from time to time.

Explain that this is the way solid waste is piled on an open dump. Over the following weeks examine the things in the jar to see if anything happens to them. (The food and newspaper will begin to change; the metal will rust; nothing will happen to the plastic or aluminum foil). Have the students make a chart to display their findings. Ask:
- Do you know the location of any open dumps in this area? What do you think of them?
- How does an open dump pollute? (Water pollution from liquids and metals leaching to groundwater. Air pollution caused by smoke from fires and gases after decomposition of materials. Many open dumps are found in wetlands, interfering with ecosystem maintenance and flood control. Odors and rat infestation. Unsightly. Uses up valuable land that is in short supply).
- What happens when we run out of space to dump?
- In what ways would it be better if the waste was buried in a sanitary landfill - one designed to prevent leaching and build-up of gases from decomposition? What problems would still remain?

g. Find out the population of your community. If each person throws out about 3.5 pounds per day, have the students calculate:
- How many pounds are disposed of per week, month and year per person?
- How many tons of solid waste are generated in your community each day?

-How much does an average family "throw away" per week?
-How much is thrown away each year in the United States based on your community's average? (Population = 225 million, answer = 144 million tons per year).

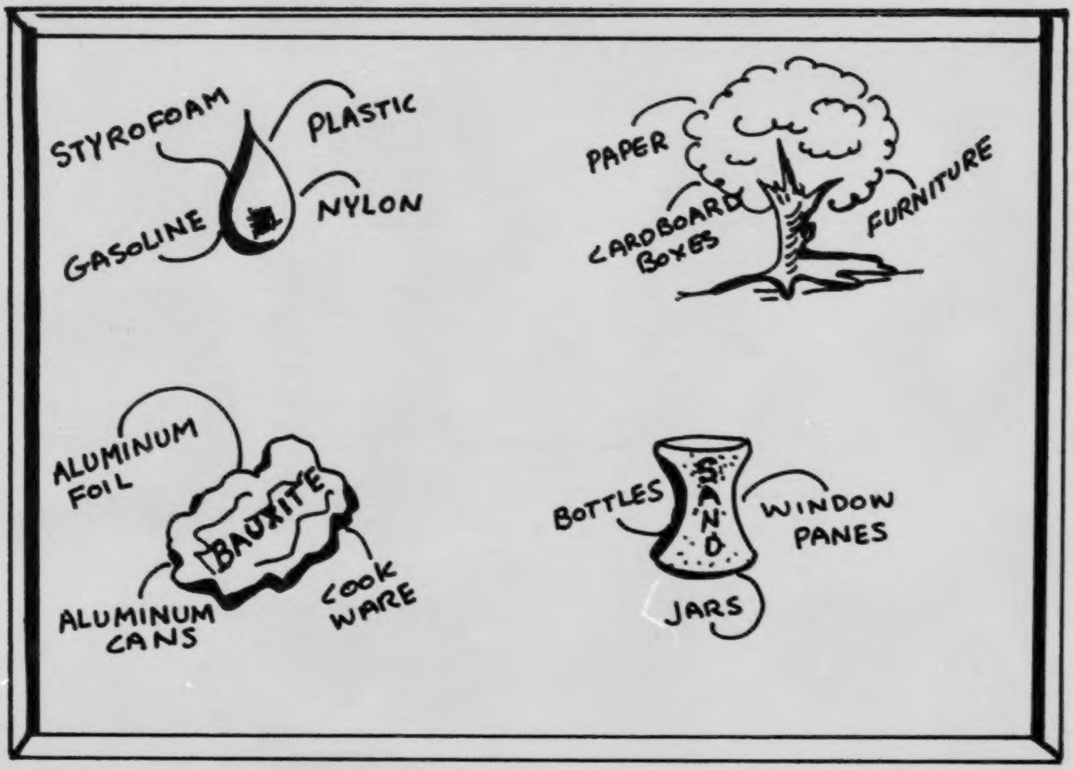
h. If possible, find out from your Department of Sanitation how much the weight and cost of waste has changed in your community over the past few years. Graph the results. Ask:
-How much does it cost our community to dispose of its refuse for one year if it cost $30 to dispose of one ton?
-Where does this money come from?

Objective #2: The students will discover why we have a lot of waste and how waste affects our resources.

a. Have the students list the different materials that compose refuse. Trace each of these back to its original source (paper to wood to trees to soil to earth; glass to sand to pebbles to rocks to earth; metal to rocks to earth; plastic to petroleum to fossil plants to earth; food to animals to plants to earth).
Investigate where different objects in the classroom came from.
Introduce the word "resource" as anything that is available for valued use or has plant, animal or human utility.
Ask:
-What are the natural resources in the above list?
-Why are natural resources important?
-Are our resources in endless supply?
-What will happen if we continue to waste our natural resources by burning, littering, dumping or burying them?
-Can we invent anything that does not use up natural resources?

b. Have the class obtain a collection of items that would normally be included in the waste stream; examples of products from natural resources such as:
Aluminum cans, from bauxite (nonrenewable).
Tin-plated steel cans, from iron and tin (nonrenewable).
Glass bottles, from sand, soda ash, and limestone (non-renewable, but in plentiful supply).
Paper, from wood (renewable).
Cardboard, from wood (renewable).
Organic waste, such as plant clippings and food scraps (renewable).
Plastic containers or bags, from petroleum (nonrenewable).

The students should examine these and discuss where the raw materials to make them come from. Have the students place the solid waste discussed into the categories of renewable and nonrenewable resources. Ask:
-Why are some materials nonrenewable? (Because they are the results of geological processes which take millions of years to complete).
-What is a problem that is occurring with the supply of some renewable resources such as paper? (It is being used at a faster rate than it can be produced commercially).


STYROFOAM
PLASTIC
GASOLINE
NYLON
PAPER
CARDBOARD BOXES
FURNITURE
ALUMINUM FOIL
BAUXITE
ALUMINUM CANS
COOK WARE
BOTTLES
SAND
WINDOW PANES
JARS

Make a bulletin board showing examples of various natural resources. Have students mount examples of products made from these resources on the bulletin board, using yarn or string to connect the product to the resource.

c. Have the students pinpoint each resource listed on a world map. State the fact that the United States, which possesses only 5 percent of the world's population, uses about 35 percent of its resources. Ask:
-Is energy a resource?
-What sources of energy are available for human use? (Oil, coal, wind, water, sun, nuclear, etc.).
-Are any of these in short supply?
-What countries are involved in supply?
-Does our consumption of resources affect the people who live in these countries?
-What could happen if other nations begin to consume as much as the United States does?
-What could happen if available resources begin to run low? What would be the effects on society?
-Does scarcity of resources increase the possibility of war?
-How can our dependency on foreign resources be lessened? What will be the effects of such actions on our society?

d. Ask the students to list the different containers that provide their evening meal. Include all the materials used to make the container. For example, for a meal of soup, hamburger, ketchup, applesauce, carrots, ice cream and milk. The list might resemble the following:

Soup-metal can with label.
Hamburger-clear plastic and styrofoam wrap.
Ketchup-glass jar, metal top, paper label.
Applesauce-glass jar, metal top, paper label.
Carrots-plastic or paper bag.
Ice cream-paper or cardboard container.
Milk-waxed cardboard container.

Calculate the total containers, then multiply one meal by three to get an estimate for one day. Next multiply the class total by the number of classes in school. Have the students make an average count of throwaway containers per family. Then multiply by the number of families for the total number of containers thrown away in your community for one day. Then multiply by 365 days in a year. Review that these containers are made of resources that are necessary for survival. Have the students imagine that all the containers the class threw away last night were stacked up in a corner of the room. Ask:

-How much of the room is occupied?
-How much of the room would a week's worth of garbage occupy?

e. Have the students conduct a survey in a local super market looking for examples of the following three types of packaging:

-Natural packages (oranges, bananas).
-Older and reusable packages (paper bags, paper wrapping, glass jars that become drinking glasses, returnable bottles).
-Modern packages (plastic, styrofoam, tin foil, individual wrappings).

Make a class list showing amounts of the various packages that were found. Construct a bulletin board of different types of packages or pictures. Ask:

-What purpose does packaging serve?
-How dependent is the product on the package?
-How could each package be reused or recycled?

From the list, have students decide which packages reduce waste and which increase waste.

f. Draw a square on the floor with chalk, approximately five feet by five feet. Ask one student to step inside the square holding one piece of solid waste, probably scrap paper. Emphasize that no one involved can step outside the square once he/she is in it.

Ask another to step in, assume they then have two children, those two marry and have two children, etc. The number will grow very quickly, yet the square remains constant. Ask the students how they would be able to get anyone out of the square. Ask all the students to return to their seats, having first dropped their pieces of solid waste in the square. Ask:

-What do you observe? (Solid waste pollution).
-What does this activity illustrate? (More people, waste pollution increases all the time).

Objective #3: The students will investigate the meaning of recycling and the savings involved in recycling.

a. Discuss the following cycles with the students. Have the students give examples which they see around them.

Nutrient cycle: Plants take up nutrients from soil to make sugar. Animals eat plants and return nutrients to soil through body wastes. Plants and animals die and decay, returning nutrients from decaying parts to soil.

Illustrate the nutrient cycle by taking a soil profile by digging out a wedge of soil about 4-6 inches deep. Use a location where there are freshly fallen leaves. Observe the layers of leaf breakdown into the rich topsoil. Peel off each layer. Ask:

-What other things besides leaves can be found in the profile that might hasten decay?

The same could be done with a rotting log. Ask:

-How do its inhabitants hasten decay?

Oxygen cycle: Plants give off oxygen as a waste product of photosynthesis. Animals take in oxygen for respiration. Animals exhale carbon dioxide. Plants use carbon dioxide for photosynthesis.

Water cycle: Sun evaporates water from oceans and other water bodies. Water vapor forms clouds when cooled. Clouds release water as rain. Plants and animals use water. Water not used runs into lakes and oceans. To illustrate the water cycle, make or show the students a terrarium. Have them observe water droplets clinging to the top. Ask:

-Where does this water come from?

-Is it necessary to ever add water to a terrarium? Why or why not?

Mineral cycle: Matter is continually being built up into mountains and then eroded into sediment. What was once sediment on an ocean floor becomes high mountains, which eventually return to the sea. New mineral matter is vented from volcanoes while other minerals are being returned to the earth's interior.

b. Do one of the following activities:

-Have the students collect dead leaves in several stages of breakdown. Ask:

What becomes of all the leaves that are on the ground in the fall?

Have the students make a large art project showing the cycle of leaves. The illustration would show how a tree's leaves fall, decay into the soil, nourish the tree by making the soil richer, and thus help the tree to grow and produce more leaves.

-Print the following words on 3 x 5 cards: soil, buds, roots, green leaves, trunk, dead leaves, branch. Distribute the seven cards to seven students at random. Give a long piece of string to the student holding the card marked soil. Have the students arrange themselves in the proper order of growth, taking hold of the string. The result should be a circle.

c. Hand out Student Worksheet 23.11. Have the students read the information, noting the steps in recycling of each of the listed materials.

d. Hand out Student Worksheet 23.12. Have students do the activity in small groups.

e. Hand out Student Worksheet 23.13. Discuss the sheet and answer the questions in class.

f. (Optional). The students may recycle paper following the directions on Student Worksheet 23.14.

Objective #4: The students will investigate attitudes toward recycling and exhibit a willingness to use, in their own lives, the things they have learned about recycling.

a. Have the students survey at least three different people concerning their attitudes toward recycling.
   Sample Survey Questions:
   -Would you be willing to source separate your garbage (for example, setting newspapers in stacks apart from other waste) so it could be more easily recycled?
   -Would you recycle? At home? At school?
   -Why would you recycle? Why not?
   -What would encourage you to recycle?
   -Which is most important to you about recycling?
    Saving money?
    Reducing pollution?
    Reducing the need for additional sanitary landfills?
    Saving energy?
   Tabulate and discuss the results of the survey.
b. Take the trash the students have previously brought to class and divide it into several piles. Assign a group of students to each pile. Have students fill out Student Worksheet 23.15 about their pile. Discuss the results.
c. Have the students make a survey of products in a supermarket that are made from recycled materials. (Look for the recycling symbol on boxes and bags). Research why there aren't more recycled materials in the market. The more we recycle the more recycled materials will begin to appear. Ask:
    Are there any barriers that favor virgin materials over recycled ones?
d. Discuss ways that businesses and the government can contribute to the solution of the solid waste problem. (For example, many businesses and commercial enterprises recycle their office paper and corrugated cardboard, and the Federal government has a program to recycle all of its high-grade office paper).
   Have the students survey local businesses to determine the amount and types of waste they produce and whether they are currently doing any recycling. (Supermarkets or chain stores are a good place to start since many of them bale and recycle their cardboard wastes.)
e. (Optional). Make a field trip to a Federal government building or private office building that has a paper recycling program.
f. Have students locate recycling centers in their own areas. Recycling center locations may be found on Student Worksheet 23.16 - 23.19 and in the telephone Yellow Pages under "recycling programs," "scrap dealers", "waste paper", etc. Have students check with the centers to find out exactly what type of materials they accept; such as: newspapers, magazines, white bond paper, glass, aluminum, bi-metal cans, etc. Set up a recycling box for the classroom. Have the students record the weekly or monthly results of their program. Follow and record the fluctuations in the selling price

of the recycled materials. Research the reasons behind these changes. Calculate the total money saved. Save any money received for a class trip.

g. Have the students make and investigate a compost operation.
-Place organic material such as fruit peels, leaves, old bread, coffee grounds, green tops of vegetables, and potato peels in a plastic bag or outside in a marked area.
-Chop and mix them up with some water and soil.
-Twist and tie the bag securely or cover the mound with earth.
-Open the bag once a day to allow oxygen inside. It is needed by the decomposers for breakdown of materials.
Discuss what is going to happen (Plant material is returned to the soil by the action of microscopic fungi and bacteria. The decomposing process enriches the soil and reduces the amount of solid waste). Have the students keep a record of the process of decay.
Note:
-Odors, texture and other changes.
-Which materials decay the fastest.
-How long it takes to complete the decay process.

h. Have the students find the answers to the following questions:
-What is the population of your community? How many families?
-How many tons of garbage does your community dispose of each day? (This information may be obtained from the Department of Public Works or the Department of Sanitation).
-How many pounds are disposed of per person per day? Per year? (The national average is 3.5 pounds per day, or 1,300 pounds per year per person, but each community is different).
-How much does it cost to dispose of the waste per ton? (The average cost to landfill in 1976 was $30 per ton.) How much does this cost your community every day? Every year?
-How is garbage disposed of in your community? Is it burned, buried, dumped? Is any of it subject to resource recovery processes, for example, separate collection of newspapers, cans and bottles?
-Is there a recycling program in your community? Is it run by the community or by private citizens?
Have the students prepare an article describing the results of this survey for the school or local newspaper.

3. Evaluation

Plan an exhibit of students' ideas of ways to reuse materials usually discarded after one use; invite parents and community to a program explaining the exhibits.

Construct a collage of trash collected by the students. Have each student identify the items and identify the energy source and materials (resources) that were used in the items manufactured. Have each student suggest a possible alternative for the items listed.

Have each student write a short paper on recycling possibilities and the rationale for recycling. Then do a follow-up study on how much the students do to recycle in their own lives.

4. Follow-Up Activities

If possible, take a field trip to:
- A local dump. Explain its operation. Discuss alternative means of disposal using the energy from solid waste.
- A glass bottle factory; report on the differences between re-used and recycled bottles.
- A papermill to see how paper is made.
- A recycling center and plan how to encourage community involvement in contributing materials to be recycled.

Given the physical properties of tin-plated steel, glass and aluminum, have the students devise a mechanical system for separating them out of the solid waste which comes from a home.

Organize a play or a fair centered around the theme of recycling and its possibilities.

Have students use samples from the class compost pile to make a wet-mount preparation and stain to use as a microscopic examination of the decomposers. Have them determine:
- How many different types of organisms can be found.
- What the landscape would look like if these organisms did not exist.
- What objects would not decay if placed in the compost pile.

300

Student Worksheet

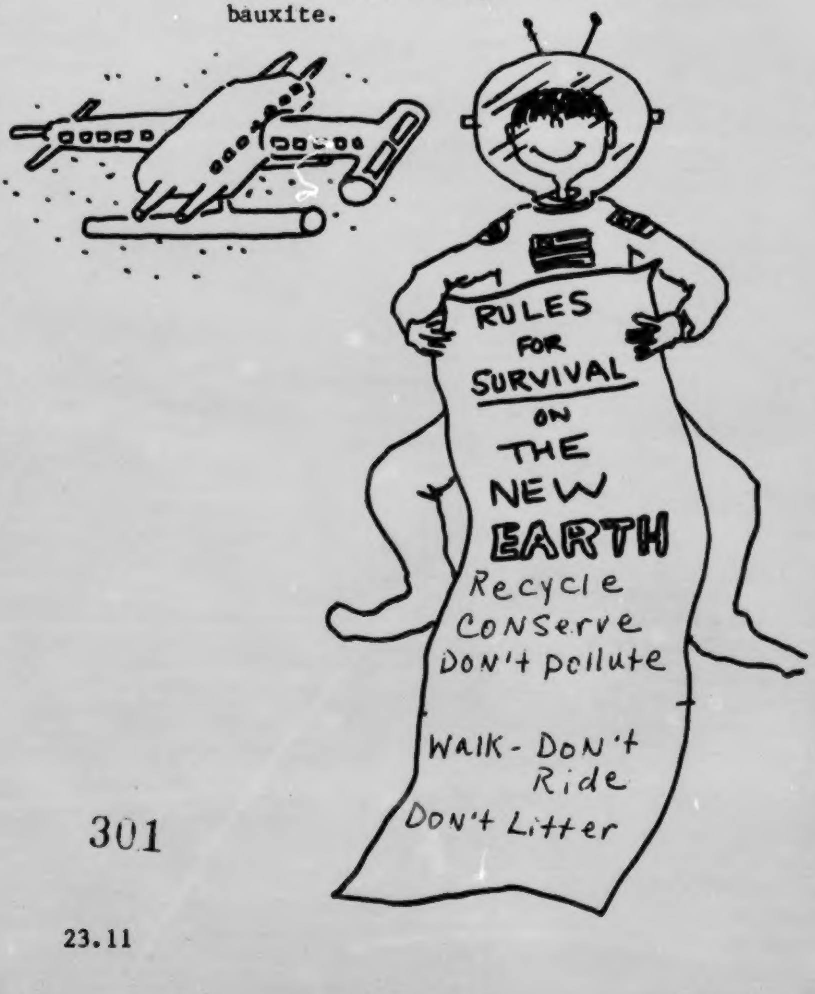
RECYCLE IT

TIN-PLATED STEEL CANS are made of iron ore and tin, neither of which are renewable resources. The cans will eventually rust and break down, so they are not as much of a problem as some other metals. However, throwing them away is a waste of valuable metals. In the recycling process the cans are put into a huge container with holes in the bottom. This container is immersed into a caustic solution which takes the tin off the cans. Then the steel cans are washed and sold as Number 1 Grade Steel. The tin is removed from the caustic solution by electrolysis and made into ingots which are sold to companies requiring tin.

GLASS is made from soda ash, sand and lime, It can remain in a disposal site indefinitely and does not break down into its organic components. To be recycled, it must first be sorted by color and crushed into small pieces called "cullet". The cullet is melted down into a solution and then molded into glass containers. Other products made from recycled glass bottles are insulations and road-patching material.

PAPER is made from a renewable resource - trees. Paper is recycled by first shredding it into small pieces and mixing it with water. This mixture is beaten into a mush-like pulp which flows onto a moving screen through which most of the water passes. The wood or paper fibers remain. The fibers are pressed through heavy rollers that remove more water and then sent through steam-heated dryers. The result is recycled paper. You can make recycled paper in class.

ALUMINUM is made from bauxite, which is a nonrenewable resource. It takes a great amount of electricity to produce aluminum. Nature cannot decompose or break it down, so disposal is a problem. When it is recycled it is melted and then shaped again into new cans and other items. Making aluminum cans from old aluminum takes only 5 percent as much electricity as from bauxite.



Student Worksheet

THE STORY OF THE ______________

Working in small groups, research a topic to complete a recycling story. Use the following questions to help you in your research.

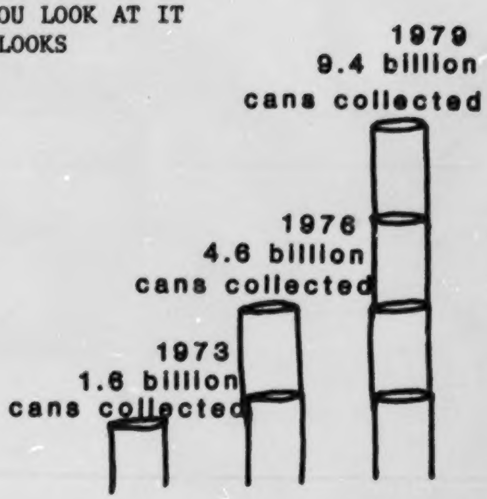
Suggested topics are:
- an aluminum can
- a plastic tube
- a cardboard box
- a tin can
- a glass bottle

I am a(n) ______________ container. Please tell my story by finding answers to the following questions:

1. What do I look like?
2. Why do I have a label?
3. What are some of the things I am used for?
4. What am I made of?
5. Where do my manufacturers get the raw materials to make me?
6. Are large amounts of raw materials available?
7. How many years will my raw materials probably last?
8. Is there any polution of the land, the air, or the water, when companies extract my raw materials from the earth?
   If so, how?
9. How do manufacturers change my raw materials to make me?
10. Does the changing of the raw materials cause pollution of the land, the air, or the water?
    If so, how?
11. Am I thrown away after I am used?
12. What chemicals are released when I am burned? Are they harmful if released into the environment? Can they be filtered and disposed of properly?
13. Do I break down into earth again if I am buried?
    If so, how?
14. Do I disintegrate if I am thrown into a river, lake, or ocean?
    If so, how?
15. What are some ways in which I could be re-used?
16. Can I be recycled? Am I recycled? Where am I recycled?
17. What happens to me when I am recycled?
18. Can I be safely burned to produce energy from the heat?
19. Who pays the real cost for manufacturing and disposing of me?
    a. The manufacturer who makes me?
    b. The company which uses me?
    c. The consumer who buys me?
20. Who is responsible for disposing of me? Who pays the cost for disposal?
21. Do you think I am a good container?
    Why or why not?

Student Worksheet

RECYCLING, THE MORE YOU LOOK AT IT THE BETTER IT LOOKS



IT'S GROWING. More and more Americans are collecting used aluminum cans. In 1979 over 9 billion cans were turned in for recycling. That is almost 6 times as many cans as were collected in 1973.

EVERYBODY BENEFITS. In the last 8 years thousands of civic groups and individual collectors have earned over $250 million through recycling. The public profits from a cleaner environment. And the used metal is put back to work.

IT CREATES JOBS. The recycling industry is growing fast. Since 1970, it has added an estimated 15,000 new jobs to the economy. Jobs that involve buying, processing, transporting and remelting used cans into new metal.

IT HELPS MUNICIPALITIES. Recycling this aluminum helps relieve over-burdened landfill facilities. And it generates extra revenue. Aluminum is the most valuable material found in quantity in municipal waste recovery system.

IT CONSERVES ENERGY. Recycling saves 95 percent of the energy needed to make new aluminum from ore. Recycling also helps reduce the consumption of coal and bauxite - both valuable natural resources.

Answer the following questions:

1. Where in your community can you take aluminum cans to be recycled?
2. Compare the number of aluminum cans recycled in 1979 with the number recycled in 1973.
3. How do you account for the difference?
4. How can the recycling industry create jobs?
5. Aluminum is made from what ore?
6. Recycling saves _____ percent of the energy needed to make new aluminum from ore.
7. _______________ is the most valuable material found in quantity in municipal waste recovery systems.
8. Why could recycling of aluminum cans be important for Arkansas?

Student Worksheet

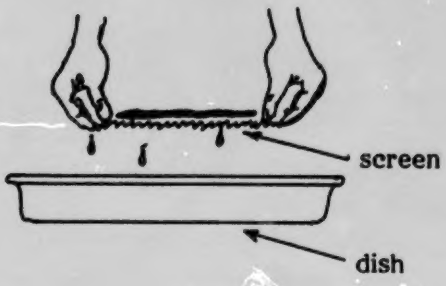
RECYCLING
ANSWER SHEET

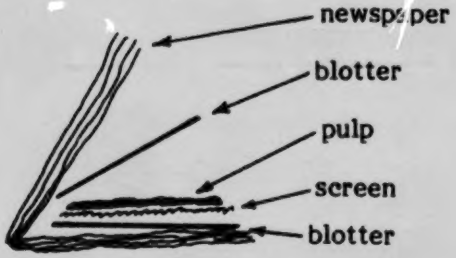
1. Answers vary with location.
2. Six times as many.
3. People want to save money, space and environment by collecting litter.
4. By buying, processing, transporting and remelting of cans.
5. Bauxite.
6. 95 percent.
7. Aluminum.
8. Arkansas has aluminum plants. Also, Arkansas, like all the states, has a need to conserve energy and minerals.

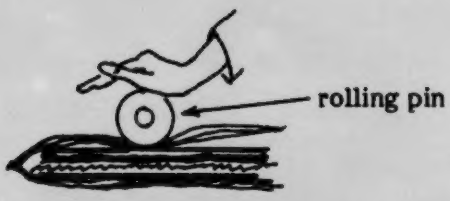
Student Worksheet

MAKE YOUR OWN PAPER

In the recycling of paper, the first step is the collection of waste paper from homes, businesses, or industrial sites. Next, the paper is separated according to "grades": newsprint, stationery, magazines, cartons, and cardboard. Each grade is recycled separately to avoid contamination with other grades. When sorted, the paper is "de-inked", a step which removes coatings, clays, inks, and binders. The cleansed paper is put into a huge vat, the hydropulper, where it is stirred and mixed with water and acids. The paper is now pulp: tiny wood fibers suspended in water. A pipe in the bottom of the hydropulper drains the pulp and pumps it onto a screen which vibrates, pressing the pulp into a flat mass. Heated drums then squeeze dry the pulp into new paper.







1. Tear newsprint into very small bits into a bowl. Pour in 2 cups of hot water.
2. Beat the mixture to make a pulp.
3. Mix in 2 teaspoons of instant starch, if desired.
4. Pour the mixture into a flat dish.
5. Slide a screen into the bottom of the dish and move it around carefully until it is evenly covered with pulp.
6. Lift the screen out carefully. Hold it level and let it drain for a minute.
7. Place the screen, pulp side up, on a blotter on some newspaper. Put another blotter over the pulp, more newspaper over that.
8. Roll a jar or rolling pin over the sandwich to squeeze out the rest of the water.
9. Take off top newspaper. Turn the blotter sandwich over so that the screen is on top. Carefully take off the blotter and screen. Don't move the pulp. There is your paper.
10. Place a dry blotter on the pulp and let it dry.

How does the cost of recycled paper compare with the cost of paper from new timber?

Student Worksheet

TRASH INSPECTION

Divide the trash previously collected into several piles. For the pile assigned to you do the following exercises:

_____Number of items in pile.

_____Number of items that can be recycled or reused.

_____Number of items that at least one person in your group recycles or reuses.

Place a check by the items below that could be done in your community.

Place a second check by the items that at least one person in your group does.

Add to the list if you can.

______ 1. Buy all-aluminum cans and take to recycling center.
______ 2. Use and reuse each piece of aluminum foil before recycling it.
______ 3. Buy only returnable bottles and return them.
______ 4. Reuse glass jars.
______ 5. Do not accept plastic bags at the grocery store or at the dry cleaners.
______ 6. Return styrofoam egg and meat containers to the stores where you purchased the items.
______ 7. Do not buy frozen foods in plastic cooking pouches.
______ 8. Take your own shopping bags to the store.
______ 9. Write on both sides of paper.
______10. Use cloth napkins, towels.
______11. Do not throw away leftovers. Use for lunches or add to pet food.
______12. Use cloth hankerchiefs.
______13. Reuse wax paper liners in cereal boxes for wrapping other items.
______14. Save and bundle newspaper.

Student Worksheet

ARKANSAS RECYCLER'S GUIDE

Source: Arkansas Energy Office

Aluminum Recycling Centers

BENTON:
Alcoa
Exit 117 Off I-30
Benton, AR 72015
776-0255/Benton
224-5303/Little Rock

Benton Salvage
Willow Street
Benton, AR 72015
847-4161/Little Rock

BLYTHEVILLE:
Ed Roleson, Jr., Inc.
Industrial Drive
Blytheville, AR 72315
763-7391

Goolsby Iron & Metal
West Highway 18
Blytheville, AR 72315
763-9086

Robertson Distributing Co.
615 North 2nd St.
Blytheville, AR 72315
763-3125

CAMDEN:
Camden Wholesale, Inc.
416 Washington, N.E.
Camden, AR 71701
836-5796

CONWAY:
Conway Scrap Metals Co.
1110 Spencer
Conway, AR 72032
329-3657

DERMOTT:
Dermott Distributing Co.
108 N. Arkansas St.
Dermott, AR 71638
538-5373

EL DORADO:
Hepco, Inc.
630 East Faulkner
El Dorado, AR 72730
862-7986

Presses Iron & Metal Wrks.
423 E. & B Street
El Dorado, AR 71730
863-9270

R.C. Edwards Dist.
621 S. Washington
El Dorado, AR 71730
863-8621

Vincent Dist. Co., Inc.
409 E. Second St.
El Dorado, AR 71730
863-9270

FAYETTEVILLE:
Coors of W. Arkansas, Inc.
750 S. Hill Street
Fayetteville, AR 72701
442-6677

Fayetteville 7-Up Botl. Co.
335 North West St.
Fayetteville, AR 72701
442-7410

McBride Dist. Co., INc.
Spring at West St.
Fayetteville, AR 72701
521-2500

Recycling Center
214 North West Ave.
Fayetteville, AR 72701
442-8160

FORT SMITH:
Belle Point Bev., Inc.
1 Garrison Ave.
Fort Smith, AR 72901
782-3511/782-7159

Burford Dist. Co.
711 S. 10th St.
Fort Smith, AR 72901
783-0537/8979/9970

Southwest Scrap Metals Co.
2610 Wheeler
Fort Smith, AR 72901
783-8931

Miller Reclamation Ctr.
3702 S. Tulsa St.
Fort Smith, AR 72901
783-8931

HARRISON:
Tom-Bar, Inc.
(Ind. Pick-Up Svc.)
906 N. Vine
Harrison, AR 72601
365-2777

HELENA:
Cantenio Dist. Co., Inc.
211 Missouri St.
Helena, AR 72342
338-6722

Coco Dist. Co.
Highway 49 Bypass
W. Helena, AR 72390
338-8097

HOT SPRINGS:
A & B Dist., Inc.
105 Winona St.
Hot Springs, AR 71901
623-3371

Fraser Sales Co.
160 Creek St.
Hot Springs, AR 71901
623-8201

KINGSTON:
Kingston Recycling Ctr.
Box 8
Kingston, AR 72742
665-2604
Attn: Ed Murrell

LITTLE ROCK:
ABC Sal. & Scrap Metals
Stagecoach Rd. at I-430
Little Rock, AR 72204
565-3132

Ark. Recycle Corp.
E. Capitol & McLean
Little Rock, AR 72202
372-6500

Student Worksheet

ARKANSAS RECYCLER'S GUIDE
Aluminum Recycling Centers
(Continued)

Blume Scrap Metals
1319 E. 6th St.
Little Rock, AR 72202
372-5864

Coca Cola Bottling Co.
of Arkansas
6901 Murray
Little Rock, AR 72209
569-2700

Coors of Central Ark.
501 Byrd St.
Little Rock, AR 72202
372-6677

P & H Dist. Co.
1900 E. 15th St.
Little Rock, AR 72202
372-5168

Reynolds Metals Co.
University & Asher
(Village Shopping Ctr.)
Little Rock, AR 72205
562-7763

Ruff Iron & Metal Co.
1401 Security
Little Rock, AR 72202
375-2309

Sol Alman Co.
1300 E. 9th St.
Little Rock, AR 72202
372-5222

Twin City Beverage Co.
1515 E. 4th St.
Little Rock, AR 72202
372-0185

McGEHEE:
Delta Dist. Co., Inc.
420 N. First St.
McGehee, AR 71654
222-3989

MORRILTON:
Otto Lienhart, Inc.
204 W. Railroad Ave.
Morrilton, AR 72110
354-2282

MOUNTAIN HOME:
Carlson & Marotti Dist.
1229 Commerce Drive
Mountain Home, AR 72653
425-9878

Zeik's Salvage
528 N.W. Hwy. 5
Mountain Home, AR 72653
425-4113

NEWPORT:
C&C Distributors, Inc.
2nd & Plum St.
Newport, AR 72112
523-2465

Sharp's Distributing Co.
100 Jacksonport Rd.
Newport, AR 72112
523-2062

NORTH LITTLE ROCK:
Metal Recycling Corp.
(Industrial Specialist)
1 Riverfront Place
N. Little Rock, AR 72118
374-9017

PARAGOULD:
Ed Roleson, Jr., Inc.
400 W. Baldwin St.
Paragould, AR 72450
236-6150

Samuels Hide & Metal Co.
86 East Hunt
Paragould, AR 72450
236-6944

PINE BLUFF:
Ace Battery Shop
2300 W. Second Ave.
Pine Bluff, AR 71601
535-3363

M.K. Distributors, Inc.
223 Mulberry Street
Pine Bluff, AR 71611
534-0364

Soltz Machinery Shop
310 Tennessee St.
Pine Bluff, AR 71601
535-8522

S. Central Coors of Ark.
Emmett Sanders Road
Pine Bluff, AR 71611
534-7676

Southeastern Dist., Inc.
2611 E. Barraque
Pine Bluff, AR 71601
536-0460

ROGERS:
Rogers Iron/Metal Corp.
730 N. Arkansas
Rogers, AR 72756
636-2666

RUSSELLVILLE:
Cunningham Metals, Inc.
Highway 7 South
Russellville, AR 72801
968-1574

SPRINGDALE:
Cottrell's Scrap Metal
Buyers
224 Candle
Springdale, AR 72764
751-9571

STUTTGART:
Ludwig Dist. Co., Inc.
503 E. 13th St.
Stuttgart, AR 72160
673-2161

TEXARKANA:
Bolls Dist. Co.
700 E. Broad St.
Texarkana, AR 75502
774-2795

Buchanan Dist. Co.
45 Globe Ave.
Texarkana, AR 75502
774-3715

Student Worksheet

ARKANSAS RECYCLER'S GUIDE
Aluminum Recycling Centers
(Continued)

JJS Distributing Co.
512 E. Broad St.
Texarkana, AR 75502
774-4185

Tri-State Iron/Metal Co.
Hwy. 67 North and E. 14th
Texarkana, AR 75502
773-8409

SEARCY:
The Thompson Co., Inc.
300 E. Mulberry
Searcy, AR 72143
268-8626

WEST MEMPHIS:
Arkansas Dist. Co.
112 South 1st St.
West Memphis, AR 72301
735-3506

Coors of Eastern Ark., Inc.
211 North 6th St.
West Memphis, AR 72301
735-0535

McCain Dist. Co.
1 McCain Blvd.
West Memphis, AR 72301
735-0992

Mid South Iron/Metals
County Highway 520
West Memphis, AR 72301
732-6340

Student Worksheet

ARKANSAS RECYCLER'S GUIDE

Paper Recycling Centers

FAYETTEVILLE:
Fayetteville Waste Paper Co.
12 & Warford
Fayetteville, AR 72701
442-4722

Recycling Center
214 N.W. Avenue
Fayetteville, AR 72701
442-8160

FORT SMITH:
Ft. Smith Waste Paper Co.
112 North East
Ft. Smith, AR 72901
783-6478

HARRISON:
Boone Wastepaper
Industrial Park Road
Harrison, AR 72601
741-5200

KINGSTON:
Kingston Recycling Center
Box 8
Kingston, AR 72742
665-2604
Attn: Ed Murrell

LITTLE ROCK:
Arkansas Recycle
E. Capitol & McLean
Little Rock, AR 72202
372-6500

Goldman & Co., Inc.
1701 E. 14th
Little Rock, AR 72202
376-7101

NORTH LITTLE ROCK
Paper Stock Dealers, Inc.
810 W. 8th
N. Little Rock, AR 72114
376-4213

OSCEOLA:
Osceola Waste Matrls.
Industrial Drive
Osceola, AR 72370
563-5461

ROGERS:
A.C.E. Recycling
P.O. Box 1224
Rogers, AR 72756
636-7391
Attn: Jim Duncan

L & L Packaging Co.
P.O. Box 1339
Rogers, AR 72756
636-5155
Attn: Roy Rogers

Individual centers offer different services to the public. Contact the recycling centers in your area to determine which one best suits your need.

LESSON #24

CATEGORY: Conservation

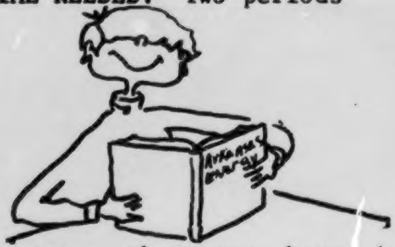
TITLE: BUY NOW!! Pay Later

INFUSE WITH SUBJECT AREA:
Social Studies
Reading

ENERGY TYPE: All

GRADE LEVEL: 7-10

TIME NEEDED: Two periods



MATERIALS:
Copies of magazines and newspapers

OBJECTIVES:

1. The students will determine if energy shortages have influenced advertising.
2. The students will discover the relationship between energy attitudes and advertisements.

TASK ANALYSIS:

The students should be able to read advertisements and draw conclusions from them.

PROCEDURE:

1. Preparation
   Gather magazines and newspapers.

2. Steps in Lesson
   Objective #1: The students will determine if energy shortages have influenced advertising.

   a. Review with the class examples of ways people have been motivated to use more energy in the past. (Advertising extolling the advantages of frost-free refrigerators; urging people to buy larger automobiles with automatic transmissions and air conditioning).
   b. Ask a group of students to examine, in a library, several issues of popular magazines such as: Life, Time, Newsweek, or National Geographic that were published 5 - 10 years ago. What advertisements urged people to buy things that used large amounts of energy?
      Ask the group to examine, also, several recent issues of the same magazines. Do advertisements now urge people to buy things that use smaller amounts of energy?
      Ask the group to report its findings to the class and provide leadership in a class discussion of questions such as:
      -Is the campaign to get people to use less energy really visible?
      -Is it likely to succeed? Why or why not?

   Objective #2: The students will discover the relationship between energy attitudes and advertisements.

a. Collect energy industry advertisements from newspapers and magazines; discuss their message to the public. Emphasize Arkansas products and publications.

b. Classify the advertising into categories. (Price rise justification; "what a good job of conservation we're doing"; cost of regulation; "survival" ads arguing for or against divestiture of competing energy sources; etc.).

c. Discuss the validity of each of the categories of advertisements collected.

d. Ask: "Are the arguments of the energy companies persuasive?"

e. Look for ads that "turn you off"; "turn you on". Discuss the reasons for the "turn off" or "turn on".

f. Collect ads from other businesses or industries that contain energy messages. (Low mileage cars, etc.).

g. Look for ads which indicate a change in approach because of the energy shortage. (Large cars emphasizing mileage and smaller size instead of luxury, etc.).

h. Ask: "Why would an electric power advertisemeent call for conservation and decreased use of electricity?" (Power companies can no longer meet the unlimited demands for electricity; federal government mandates that utilities spend a certain percent of gross income to educate the public in the need for energy conservation and ways to do it).

i. Create a "billboard" advertisement for your school which stresses conservation of electricity.

j. Start a class magazine.
   - -Decide on a name for your magazine.
   - -Divide the class into several editorial boards which will suggest topics for inclusion in the magazine.
   - -Design the magazine on the basis of their recommendations.
   - -Design a cover for the first issue.
   - -Write an advertisement to appeal to new subscribers for the magazine.
   - -Write the first editorial on energy.
   - -Write a letter to the editor answering the first energy editorial, either supporting or criticizing it.
   - -Write an article which describes for your future son or daughter the present energy situation, and what is being done about it.
   - -Write your future child's answer to your article on the energy situation.
   - -Illustrate any articles written.

ARKANSAS
ENERGY

k. Have the students write "unlikely" energy headlines. Display these and have students explain them to the rest of the class.

Little Rock
Museum of Science & History
sets up new exhibit:
"Down with Solar"

AP&L CLOSES DOORS!!
Put out of business by new
patented bicycle generators
for homes.

ARKLA Gas lowers rates!

Arkansas Energy Office
predicts-
"Natural Gas to last 2.5
billion years!"

1982 Volkswagons to get
5 miles per gallon.
Get them while they last!!

3. Evaluation

Have students make an Arkansas energy advertisement collection. Have them evaluate the validity of each ad included.

Use oral evaluation of ability to understand advertisements and their effects during class discussions.

4. Follow-Up Activities

Invite a class speaker from one of the advertising companies or from one of the publications carrying the advertisements used in class.

Design and produce a television commercial, a radio commercial, or a newspaper advertising format.

LESSON #25

CATEGORY: Conservation

TITLE: Don't Get in Hot Water!

INFUSE WITH SUBJECT AREA:
Math
Social Studies

MATERIALS:
Optional:
Topographic maps

ENERGY TYPE: All

GRADE LEVEL: 9-12

TIME NEEDED: Two periods

OBJECTIVES:

1. The students will calculate the amount and cost of their family's water consumption per week and per year.
2. The students will determine ways they might conserve water.
3. The students will make a study of energy-related water problems in Arkansas.

TASK ANALYSIS:

The students should be able to do basic math computations.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 25.4 - 25.7.
   Gather above-listed materials.

2. Steps in Lesson
   Objective #1: The students will calculate the amount and cost of their family's water consumption per week and per year.

   a. Have students brainstorm ways that hot water is used in the home. List these ways on the chalkboard. Rank these hot water uses based on a class estimation of the quantity of hot water needed for each task.
   b. Have each student complete the calculations on Student Worksheet 25.4. Allow 30 - 45 minutes for this task. Discuss the answers as a group.
   c. Have the students do the calculations and answer the questions on Student Worksheet 25.5. The worksheet may be worked in its entirety or the amount of hot water calculated on Student Worksheet 25.4 may be used. Discuss the answers as a group.
   d. Question #7 on Student Worksheet 25.5 asks students to consider ways of cutting down hot water energy use in their homes. Here students may want to initiate research outside of the classroom or to brainstorm as a class a list of ways to eliminate waste in the production and use of hot water in the home.

Objective #2: The students will determine ways they might conserve water.

a. Have students follow these directions to determine which takes more water, a shower or a bath:
Fill the bathtub with water as usual, but before you step in, use a yardstick to measure the depth of water in the tub. The next time you are going to bathe, close the bathtub drain and take a shower instead of a bath. When you are finished, measure the depth of water that has collected. Compare this reading with the bath water depth. Which takes more water? Why does more water mean more energy?

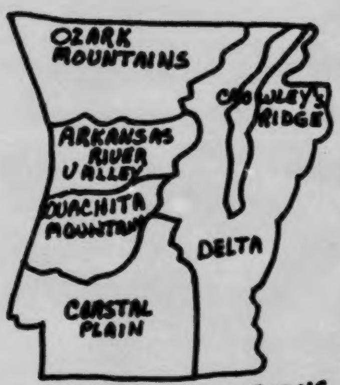
b. Hand out Student Worksheet 25.6. Direct students to bring the filled-in sheet to the next class meeting. Discuss the results in class.

c. (Optional). Have the students survey a wide variety of community people, using Student Worksheet 25.7. Compute the results of the survey and write a related article for the school and/or community newspapers.

d. (Optional). Secure a topographic map(s) of the area that includes the community water filtration-pumping station and the residences of the students in the class. Involve the students in learning how to read elevation levels on a topographic map and ask students to determine the difference in elevation between the pumping plant and their homes. (Homes will almost always be higher than the pumping plant).
Ask the students to obtain from their parents a record of the amount of water used in the home during the past 3 or 6 months (or use amounts from Student Worksheet 25.4). The weight of water used can be calculated since one cubic foot weighs 62.5 pounds. The height the water was lifted is known from the elevation differences found on the topographic map(s).
Since work can be measured in foot/pounds the evalation difference times weight of water used equals the minimum work done to deliver water to the family. Review other factors that would increase this amount such as: friction, height of water supply standpipe, etc.
Compare results obtained for each household. Which one required more energy to have its water delivered? Why? Is wasting water also wasting energy? What are some very obvious ways to save water and thus electricity?

e. Give the class this informtion: There is a severe drought causing the immediate rationing of water. All families must reduce their water usage by at least 20 percent. Divide the class up into "families", have each student determine which family member he/she will be. Have the families answer the following questions:
-How would you cope with the rationing?
-What areas of water use would you cut back?
-Rank those areas you would cut back: 1st, 2nd, etc.
-What methods can be used to institute and enforce conservation in these areas of water usage?

Objective #3: The students will make a study of energy-related water problems in Arkansas.



NATURAL DIVISIONS OF ARKANSAS

a. Divide the class up into six groups. Assign each group one of the six natural divisions of Arkansas, as shown at the left. Have each group research and report to the class on:
-Uses of water in their division.
-The problems with water created by these uses.
-How these problems affect Arkansas' energy situation.
For example: The Ozarks have small streams easily polluted by tourism. This means an increased need for energy-using sewage treatment plants.
Possible references:
Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.
Thomas L. Foti. The Natural Divisions of Arkansas. Arkansas Ecology Center: Little Rock. 1978.
William L. Fulton. Reading the Environment. Arkansas Department of Education: Little Rock. 1978.

3. Evaluation

Check answers to Student Worksheets.

Have students make statements on how they intend to conserve water in the future.

4. Follow-Up Activities

Have students analyze hot water energy consumption for the entire school using the class as a random sample of school population, based on Student Worksheet 25.4.

Let individual students investigate alternative energy sources and their potential for meeting hot water needs in Arkansas.

Find out: Water sources: How is your water treated.
What is added to your water? Why?
How to read your water meter (1 cubic foot = 7.5 gallons).

Study the distribution of the world's water resources. Compare world maps showing rainfall and population distribution. What conclusions can you draw? What areas have recently experienced severe drought?

Student Worksheet

HOUSEHOLD WATER CONSUMPTION

Water utility studies have reported the average consumption of water in households as recorded in the table below.

Activity	WATER CONSUMPTION
Toilet	4 gallons/flush
Shower	30/gallons/shower of 7 gal/minute
Bathtub	40 gallons/bath
Washing machine	40 gallons/load
Dishwasher	40 gallons/load or sinkful
Drinking	1 gallon/day
Food preparation/household	100 gallons/day
Washing face in sink	1 gallon
Watering lawn	10 gallons/minute

Answer the following questions and perform the calculations required to estimate the water consumption of your household.

1. How many people in your family?__________
2. How many showers per week do you take?__________
3. How many baths per week do you take?__________
4. On the average, how many times daily do you flush the toilet?__________
5. In summer, how many hours per week does your family water the lawn?________
6. How many washing machine loads does your family run per week?__________
7. How many times per day is your dishwasher run or dishes washed by hand?____
8. Water consumption from showers in gallons per week:
   ____________ X ____________ X 30 gal/shower = __________gal/week.
   Q. #1 answer   Q. #2 answer
9. Water consumption from baths in gallons per week:
   ____________ X ____________ X 40 gal/shower = __________gal/week.
   Q. #1 answer   Q. #3 answer
10. Water consumption from flushing toilets in gallons per week:
    ____________ X ____________ X 7 da/wk/ x 7 gal/flush = __________gal/week.
    Q. #1 answer   Q. #4 answer
11. Water consumption from washing clothes in gallons per week:
    ____________ X 40 gallons/load = __________gal/week
    Q. #6 answer
12. Water consumption from dishwashing in gallons per week:
    ____________ X 40 gallons/load or sinkful X 7 days/week = _________gal/week.
    Q. #7 answer
13. Water consumption from watering lawn in gallons per week.
    ____________ X 60 minutes/hour x 10 gallons/minute = __________ gal/week.
    Q. #5 answer
14. Water consumption in bathroom sink (washing face 3 times per day):
    ____________ X 3 times/day X 7 days/week X 1.5 gallon/wash = ______gal/week.
    Q. #1 answer
15. Water consumption from food preparation and household (family of 5):
    100 gallons/day X 7 days/week = 700 gallons per week.
16. Total water consumption per week: __________ + __________ + __________
    Q #8   Q #9   Q #10
    + ________ + ________ + ________ + ________ + ________ = ________gal/week
    Q #11   Q #12   Q #13   Q #14   Q #15
17. Total water consumption per year:
    ____________ X 52 weeks/year = __________ total gallons water per year.
    Q. #16 answer

Student Worksheet

ENERGY COST SHEET

1. The average family in the United States uses 20 gallons of hot water per person, per day.
2. It requires approximately 800 BTU's per gallon to heat and maintain water at 140 degrees Fahrenheit.
3. The cost of 100,000 BTU's if energy is:
   Natural gas: 1,000,000 BTU = 98 cubic feet = 19.2 cents per cubic foot.
   Electricity: 1,000,000 BTA = 30 kilowatt-hours = $1.23 average
   ($1.41 AP&L)

Source: Arkansas Energy Office

Answer the following questions:

1. How many persons in your family?__________
2. How many gallons of hot water does your family use? Per day__________; per week__________; per month __________; per year __________.
3. What are the number of BTU's necessary for your energy needs? Per day_______; per week_______; per month_______; per year_______.
4. What fuel does your home use for heating hot water? __________________
5. Calculate the cost of hot water in your home for your family. Per day_______; per week_______; per month_______; per year_______.
6. Find another member of the class whose family uses the same number of BTU's but uses a different energy source. Compare your results with his/hers.

7. List 5 ways you can reduce hot water energy usage in your home.

   1.

   2.

   3.

   4.

   5.

8. Estimate the percentage energy-savings if these 5 ways were implemented for a year.

Source: Florida Department of Education

Student Worksheet

WATER WASTE

What to do

1. Use a leaky faucet if you have one -- if not, adjust your faucet to produce a steady drip (cold water please).
2. Place an 8 ounce measuring cup underneath the dripping faucet.
3. Collect the drips for 15 minutes. For example: 4 ounces in 15 minutes.
4. To find the number of ounces per hour, multiply the number of ounces collected in 15 minutes by 4.
5. Multiply this answer by 24 to find the number of ounces per day leaking through the faucet.
6. Multiply this answer by 365 to find the number of ounces per year.
7. Divide this answer by 128. This gives the number of gallons per year leaking through the faucet.
8. If you have a natural gas hot water heater and if a leak was in your hot water faucet, what do you suppose would be the cost to you and the waste in energy?
    a. Divide the answer you obtained in question #7 (gallons wasted per year) by 0.84. This will be the number of cubic feet of natural gas wasted.
    b. Multiply the number of cubic feet wasted per year by the current price the utility is charging each residential customer for each cubic foot of gas he/she uses. 1978 price of natural gas for the residential sector of Arkansas was $1.96/MFC or 19.6 cents per hundred cubic feet.
9. If you have an electric hot water heater and if a leak was in your hot water faucet, to find out how much energy you could waste and how much money you would spend unnecessarily if it was not repaired you need to:
    a. Multiply the answer you obtained in #7 by 0.25. This gives the approximate number of kilowatt-hours of electricity wasted.
    b. Multiply the number of kilowatt-hours wasted per year by the current price the utility is charging each residential customer for each kilowatt- hour used. In Arkansas, the 1979 price of electricity for the residential sector was 4.1 cent per kilowatt-hour.

= WASTED ENERGY

Student Worksheet

COMMUNITY SURVEY ON WATER NEEDS

Name ______________________________

Position (job title) ______________________________

1. Where does the community get its water?

2. Why is it obtained from this source?

3. Has there ever been a water shortage in this community?
   When? Why? How severe?

4. What action was, is, or should be taken during a shortage:
   a. By individuals

   b. By community

   c. By industry

5. Are there any dependable alternate sources for community water supply?

6. What plans have been made to meet future water needs?

7. Is the community recycling water?

8. Does the community supply water to any large industries?
   If so, how many gallons per day?

9. How much water is distributed daily to residential areas?
   To businesses?

10. What is the present price rate structure for community water?

11. Does price rate differ for homes, businesses, or industries?
    Is rate dependent upon total amount used?

LESSON #26

CATEGORY: Conservation

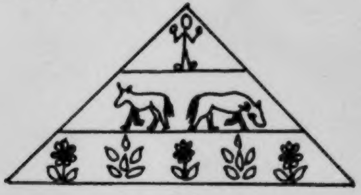
ENERGY TYPE: All

TITLE: Food and Energy

GRADE LEVEL: 8-10

INFUSE WITH SUBJECT AREA:
Science
Home Economics
Social Studies

TIME NEEDED: Two periods



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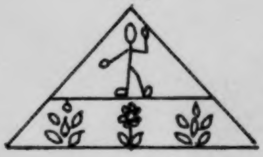


MATERIALS:
Optional (for groups of 3 - 4):
Pictures of producers, consumers and decomposers
Wire, dowels or straws
1 spool strong thread
Scissors
Glue

OBJECTIVES:

1. The students will discover the relationship between energy, efficiency, and the fuels and foods produced by plants.
2. The students will trace the energy forms used to bring a hamburger to their table in order to identify energy consuming steps in the food system and select ways to save energy.
3. (Optional). The students will determine the most efficient and economical means of cooking meals.

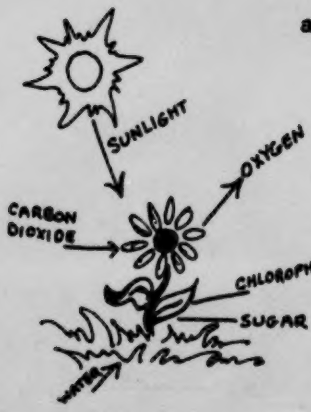
TASK ANALYSIS:

The students should be able to do basic math computations; and be able to follow a recipe.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 26.6 - 26.8.
   Gather above-listed materials.

2. Steps in Lesson
   Objective #1: The students will discover the relationship between energy, efficiency, and the fuels and foods produced by plants.



a. Ask: "What is the most important chemical reaction on earth?" (The reaction in which the sun's radiant energy is absorbed by chlorophyll in green plants to produce the chemical energy which sustains life).
Review the process of photosynthesis. (Breaking down of water and carbon dioxide taken in by green plants to sugar - a composite of carbon, hydrogen, and oxygen - thus capturing and storing the sun's energy).
Ask: "How do animals use this stored energy?" (To do muscular work; keep warm; generate nerve impulses; make proteins and other molecules for building new cells).

Review the kinds of plant foods we eat and determine the plant parts which store energy. (The parts which store most of the energy are the parts we eat).

Ask: "Are there any plant parts that are not used for the storage of energy?" (No, they will all burn).

"What are some possible uses for those parts of the plant we do not eat?" (Fuel, fertilizer).

b. (Optional). Have the students, either as individuals or in small groups, construct a mobile representing a simple food chain (pyramid). Remind them that the bottom of the mobile represents the sun. After the mobiles are completed, display them to the class and discuss the following questions:

-Where in the mobiles are the meat-eaters? The vegetarians?

-What is the relationship between the type of animal or plant and its position in the mobiles?

-Where are the primary producers in each mobile? What happens when you remove one? When you remove several?

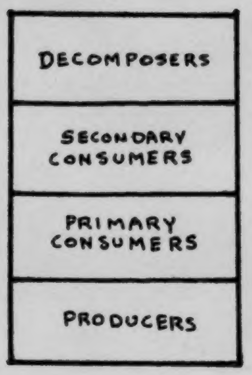
-Where are the primary consumers? What happens when you remove one? Several? How does the result compare with the result when you removed one or more producers?

-What is the final consumer in each mobile? What other organisms could be at the top of the pyramid?

-Does a disturbance at certain levels of a mobile result in greater change than disturbances at other levels? Explain this.

-How does the complexity of a mobile affect its susceptibility to change? How do you explain this?

-What implications does what you have observed in this exercise have for ecosystem management, particularly as relative to diversity?



c. Ask students to keep track of all the food they eat in a week, including the weight in grams; caloric value; and cost (using average retail price locally) of each item (including food eaten at home). Food labels or cookbooks might be used to determine caloric values. Have them use a chart such as the one below for organizing data.

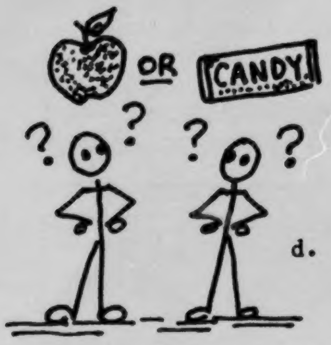
Type and amount of food	Cost per unit of measure	Caloric Value	Weight in grams	Cost per gram	Cost per calorie
1 apple 1/2 lb.	40c/lb. 20c.	117 cal	360 g.	.056c	.0017c.

Have the students:

-Compare the cost (price) per calorie of the food items.

-Determine whether there is a general class of foods (such as plant, animal) where a high concentration of calories per gram is found.

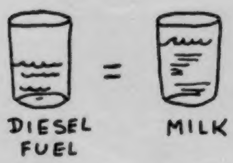
-Determine what other nutritional value besides calories various foods provide for us. (Again cookbooks or food labels may be helpful; in addition nutritional information can be obtained from

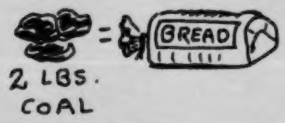


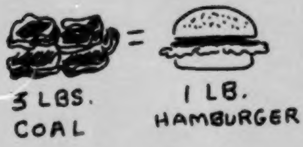
the Cooperative Extension Service in the United States Department of Agriculture.)
- -Analyze the monetary cost (price) per unit of various foods in terms of the amount of protein, carbohydrates, specific vitamins, and minerals each provides.
- -Determine what is the "best buy" based on which nutrients the students consider to be of most value to them.

d. Hand out student Worksheet 26.6. Have the students do the activity individually, then display their results to the class.

Objective #2: The students will trace the energy forms used to bring a hamburger to their table in order to identify energy consuming steps in the food system and select ways to save energy.

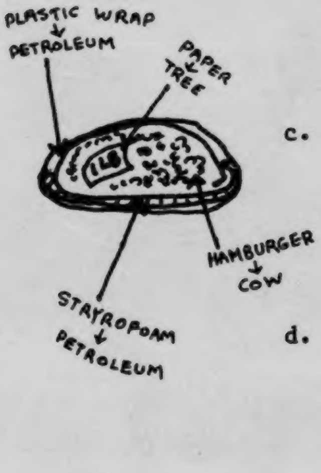






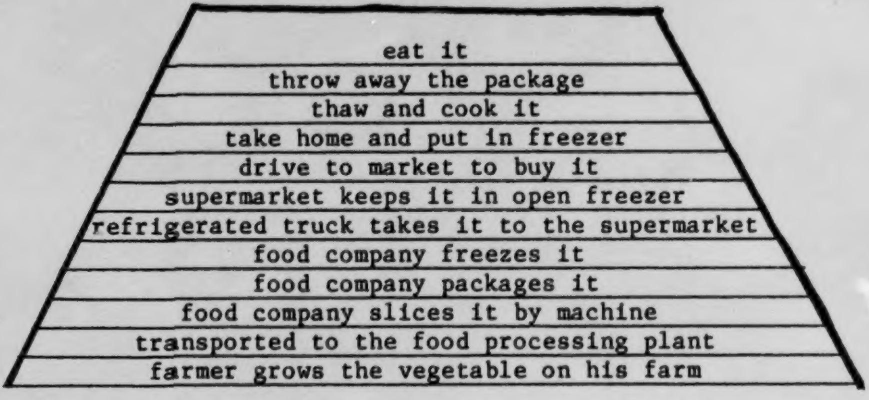
a. Hand out Student Worksheet 26.7. Do the activity as a class. Students may be interested to know that according to one study it takes the equivalent of a half-glass of diesel fuel to put one glass of milk on the table; the equivalent of two pounds of coal to produce a one-pound loaf of bread; and three pounds of coal to produce one pound of hamburger. Actual farming takes less than 1/5 of the total food production energy; the other 4/5 is spent on fertilizers and insecticides used to grow the food, farm equipment, transportation to market, processing and packaging and preparation.

b. Discuss the pros and cons of the following suggestions for saving energy in the food system:
- -Ship food products by train rather than truck or plane.
- -Encourage storekeepers to use closed freezers and coolers instead of open ones.
- -Suggest to storekeepers that they cut back on store lighting and heating.
- -Form food cooperatives and buy food in bulk delivered to a central distribution point.
- -Grow home gardens; compost organic waste.
- -Use fewer convenience and pre-prepared foods.
- -Eat more high-protein vegetables and grain (whole wheat, brown rice, corn meal, beans and peas).



c. Discuss indirect energy costs such as mining the aluminum ore and growing the trees to make aluminum foil and paper for packaging; the manufacture of steel for processing equipment and transportation vehicles; the design of packaging and the production of television commercials; and much more in between. Brainstorm the number of people involved in bringing the hamburger to the table.

d. Have the students look at the steps below in the preparation and eating of a frozen vegetable. Have them propose steps which could be eliminated to save energy.


eat it
throw away the package
thaw and cook it
take home and put in freezer
drive to market to buy it
supermarket keeps it in open freezer
refrigerated truck takes it to the supermarket
food company freezes it
food company packages it
food company slices it by machine
transported to the food processing plant
farmer grows the vegetable on his farm

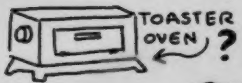
ARKANSAS
BRAND
FROZEN
VEGETABLES

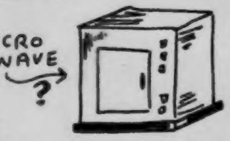
The answers will vary. Growing vegetables in your own garden and eating vegetables raw are the two least energy intensive steps. Have the students construct a pyramid for soft drinks in cans, TV dinners, ice cream, cereal, etc. Find ways of saving energy for each item.

e. Hand out Student Worksheet 26.8. Have the students complete the chart at home or in a food store. Discuss as a group the results.

Objective #3: (Optional). The student will determine the most efficient and economical means of cooking meals.

a. Have students choose a recipe for a roast, cake, etc. Have some prepare the food in an electric oven, a microwave oven, a toaster oven, and a crockpot. Determine the wattage of each appliance by reading the label on each. Next convert this to kilowatts. Have students check the recipes for the time needed to bake or cook in each appliance. Multiply this time by the number of kilowatts. This converts the information into kilowatt-hours. To determine the cost of using this much energy, multiply the kilowatt-hours by the local cost per kilowatt-hour. (This activity may be done at school if equipment is available, at home if not).
Have students discuss the following questions:
-What is the cheapest appliance to operate?
-Which appliance uses the least energy?
-Is there any difference in the quality of food cooked?
 If so, which is the preferred appliance?
-What are some ways you can conserve energy in cooking?





3. Evaluation

Have students keep a record of money saved when they apply energy-saving techniques to their market trips and to food preparation.

Ask students to plan menus for a day's meals which use the minimum amount of energy.

4. Follow-Up Activities

Have the students consider the economics of food processing. How high is the cost of wrapping as compared to the cost of the food itself?

Have the students calculate the energy consumed for marketing trips and plan ways to save energy on their family trips.

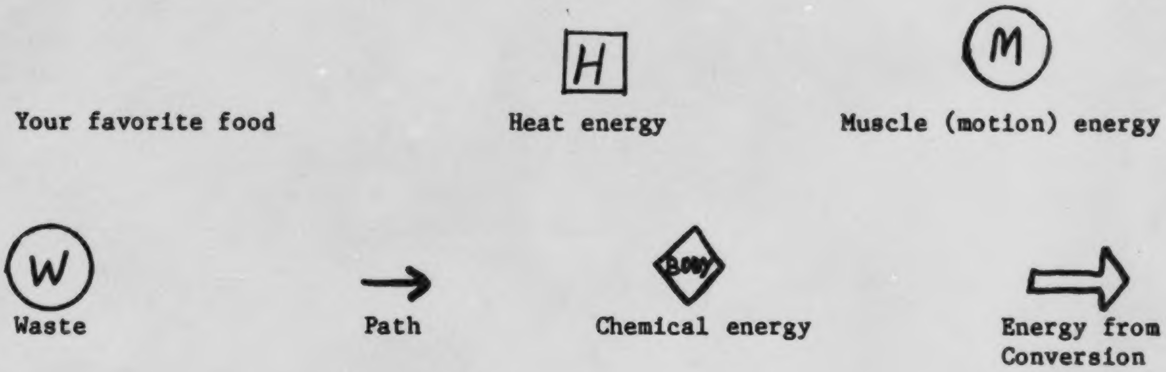
Have the students trace the population shift in the United States over the past 100 years from an agrarian to a semi-rural nation to our current predominantly urbanized society. Have the students discuss the following questions:

- -How has the population shift changed the methods used to market products and affected the kind of products sold?
- -What changes over the years have occurred in the handling, processing, transporting and storing of products? How has packaging contributed to these changes?
- -What effects did the changes in employment, per capita income level and education over the years have on the packaging of products? Are there indications that packaging will be more significant in the future? Why or why not?
- -What are the food industries? (Growers, processors, beverage firms, wholesalers, retail stores, and restaurant/institution).
- -How has the packaging changed food processing and marketing?
- -How has packaging changed the consumption of food by consumers? The productivity of farms? Seasonal availability of food? Costs?

Student Worksheet

HOW YOU USE YOUR FAVORITE FOOD

Choose your favorite food. Draw a symbol in the space below to represent this food. Show the "pathway" the energy from your favorite food takes from the time you eat it until the use you make of it. Do this as a flow chart.


H
M
Your favorite food
Heat energy
Muscle (motion) energy
W
BODY
Waste
Path
Chemical energy
Energy from Conversion

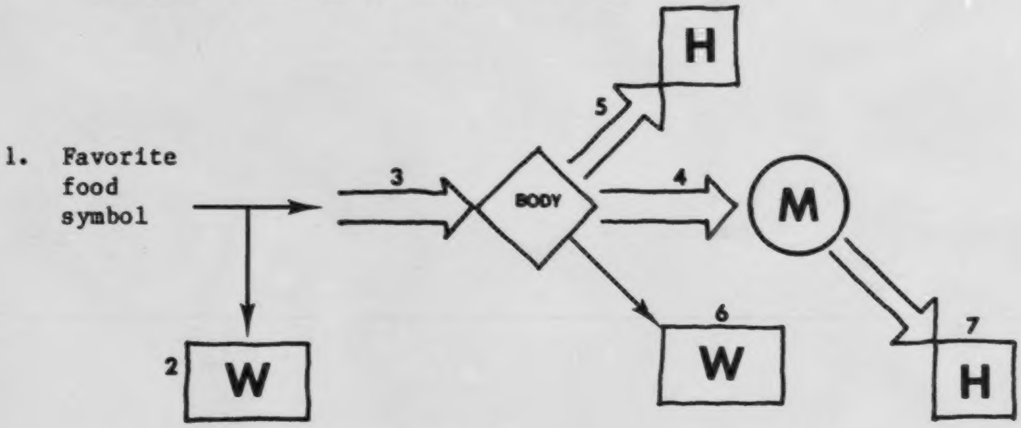
Draw your flow chart below, using the above symbols as many times as necessary.

Student Worksheet

HOW YOU USE YOUR FAVORITE FOOD
ANSWER SHEET

A flow chart is a form of mapping. It maps an event. In this case, energy flowing through the human body is the event being mapped.

1. Food input
2. Food not eaten = waste
3. Conversion of food energy for body use
4. Conversion of energy to energy of motion
5. Conversion of energy to heat energy
6. Energy not used by body = waste
7. Conversion of energy of motion into heat energy



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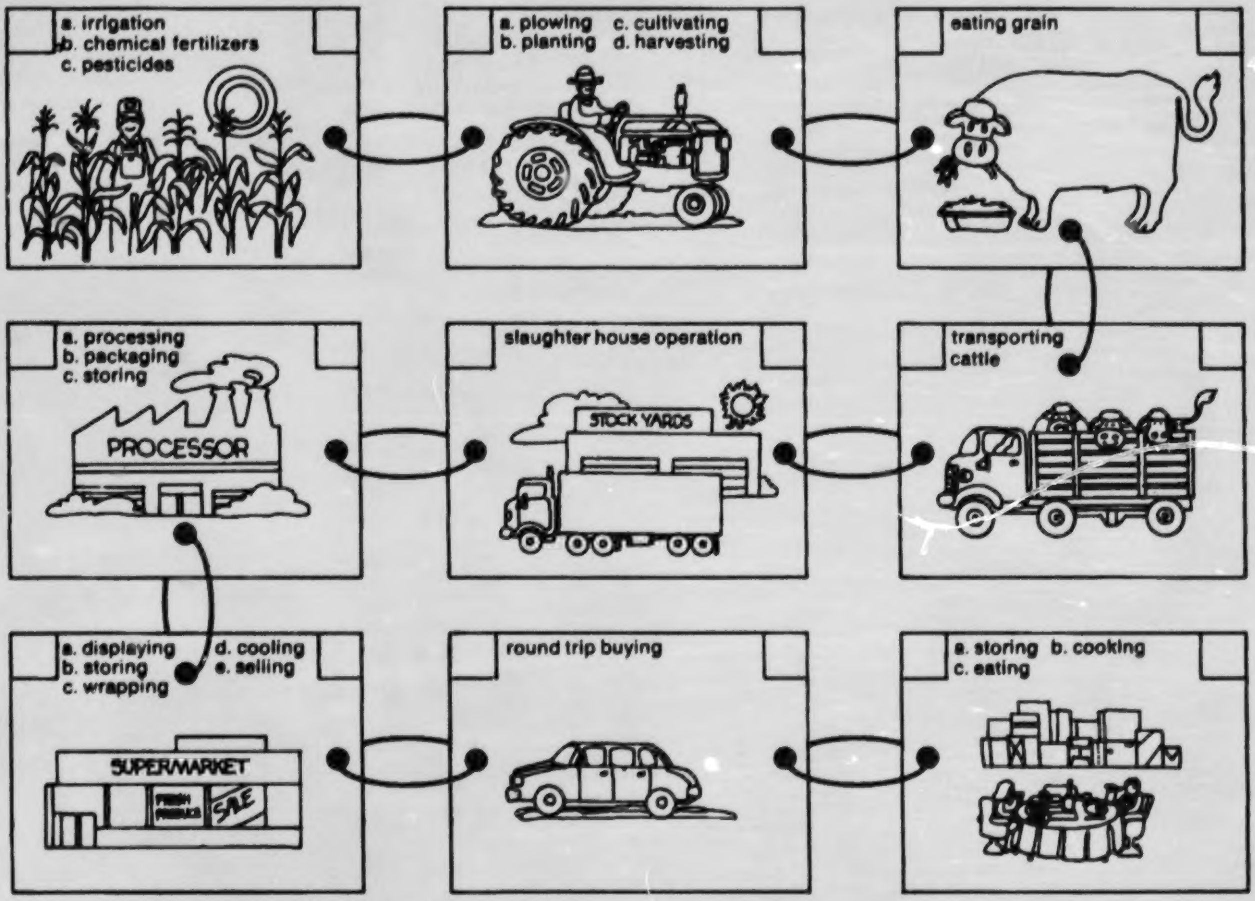
Student Worksheet

ENERGY ALONG THE FOOD CHAIN

It is so easy to go to the supermarket and pick up a gallon of milk or a pound of hamburger that we do not stop to think about the energy it takes to produce the food we eat. The growing of crops and the processing, transporting, packaging, sorting, marketing, and preparing of food - all use large amounts of energy resources. Let's take a look at these links of the "food chain."

On the diagram below, trace the steps required to bring a hamburger to your table. Number the steps in the left hand box and put an X in the right hand box at each step that uses fossil fuel energy resources (coal, petroleum, natural gas).


a. irrigation
b. chemical fertilizers
c. pesticides
a. plowing
b. planting
c. cultivating
d. harvesting
eating grain
a. processing
b. packaging
c. storing
PROCESSOR
slaughter house operation
STOCK YARDS
transporting cattle
a. displaying
b. storing
c. wrapping
d. cooling
e. selling
SUPERMARKET
FRESH PRODUCE
SALE
round trip buying
a. storing
b. cooking
c. eating

In the spaces below, put the numbers of the steps of the food chain that are required in the production of:

a quart of milk ______________

tomatoes from your garden ________________

a loaf of bread ______________

a TV dinner ________________

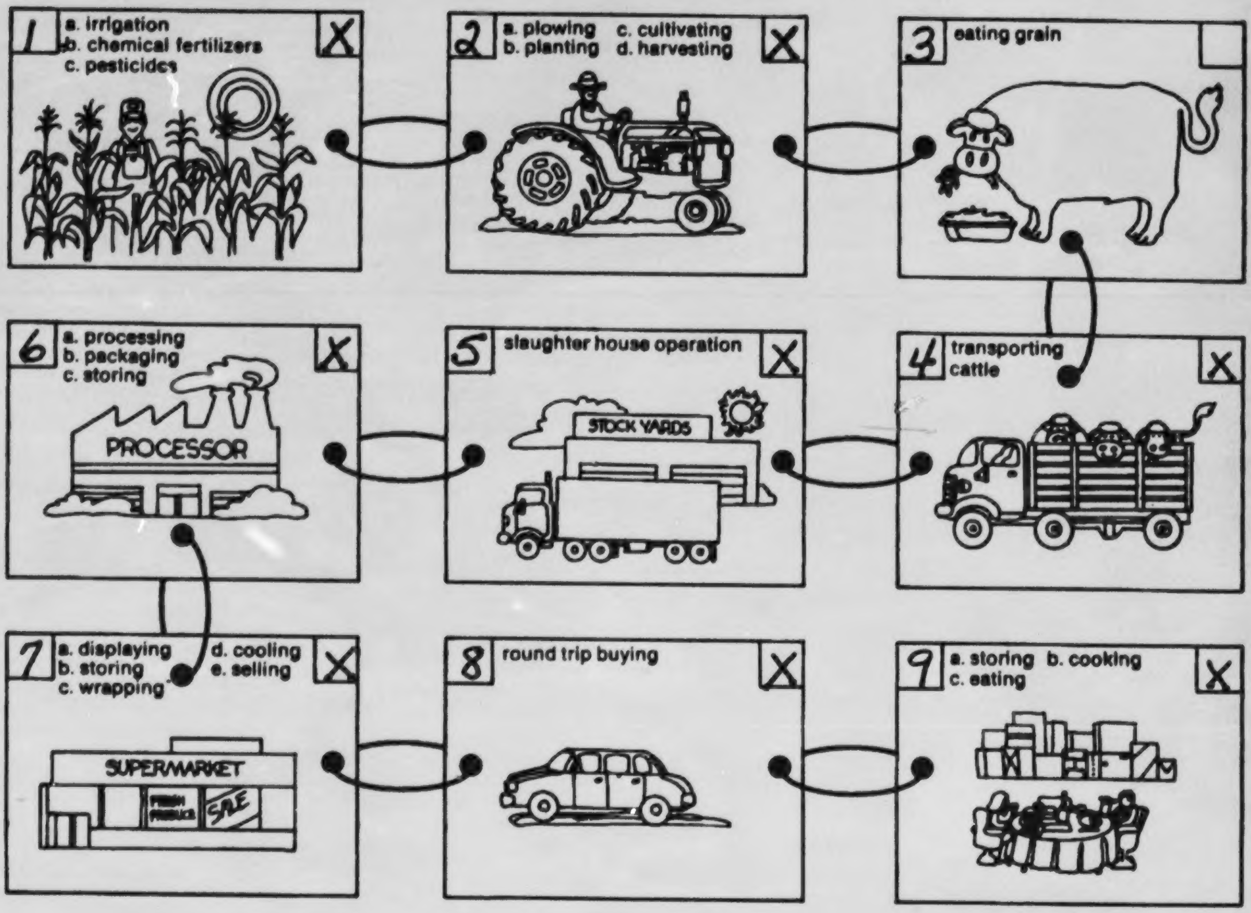
a can of tomato soup ________

fresh produce from a farmer's stand ________

Source: United States Department of Energy

Student Worksheet

ENERGY ALONG THE FOOD CHAIN
ANSWER SHEET


1 a. irrigation b. chemical fertilizers c. pesticides ☒
2 a. plowing b. planting c. cultivating d. harvesting ☒
3 eating grain ☐
6 a. processing b. packaging c. storing ☒
PROCESSOR
5 slaughter house operation ☒
STOCK YARDS
4 transporting cattle ☒
7 a. displaying b. storing c. wrapping d. cooling e. selling ☒
SUPERMARKET
FRESH PRODUCE
SALE
8 round trip buying ☒
9 a. storing b. cooking c. eating ☒

In the spaces below, put the numbers of the steps of the food chain that are required in the production of:

a quart of milk 1,2,3,6,7,8,9

a loaf of bread 1,2,6,7,8,9

a can of tomato soup 1,2,6,7,8,9

tomatoes from your garden 2,9

a TV dinner 1,2,3,4,5,6,7,8,9

fresh produce from a farmer's stand 2,8,9

Student Worksheet

WHERE DOES OUR FOOD COME FROM?

Complete the following chart for as many different foods as you can. This may be done at home or at a food store.

FOOD	FORM OF WRAPPING	PLACE OF PACKAGING	PLACE WHERE GROWN	IMPORTED OR DOMESTIC	ARKANSAS PRODUCT

Answer the following questions:

1. How many of these foods were grown in Arkansas?
2. How many could be?
3. If it is grown in Arkansas, do we still import it from elsewhere?
   If so, why?

LESSON #27

CATEGORY: Conservation

ENERGY TYPE: All

TITLE: Premeditate: Insulate

GRADE LEVEL: 9-12

INFUSE WITH SUBJECT AREA:
Social Studies
Science
Home Economics
Math

TIME NEEDED: Three periods

MATERIALS:
Energy conservation booklets
Metal fruit juice cans for class groups of 3-4
Enough of the following to insulate one juice can:
Styrofoam
Newspaper
Cloth
Fiberglass
Plastic
Commercial insulation
Glass
Wood
Aluminum foil
Ice cubes - one per group of 3-4
1 pencil per class member
1 roll cellophane tape
1 carton plastic food wrap
1 cardboard shoebox
1 thermometer

OBJECTIVES:

1. The students will gain insight into conservation of energy through use of insulation materials.
2. The students will look at a comparison of the insulating efficiencies of various materials.
3. The students will determine how insulation can save on utility bills.
4. The students will determine that draperies and curtains can prevent energy loss.
5. The students will research methods of insulation used by various groups.
6. The students will understand the meaning of R-values

TASK ANALYSIS:

The students should be able to follow directions to construct apparatus; be able to conduct independent research; and make a presentation of research findings.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 27.7 - 27.15.
   Read Teacher Background Information (27.5 - 27.6).

Gather above-listed materials.
Order the following: The Home Energy Check and The Arkansas Energy Saving Handbook for Homeowners from the Arkansas Energy Office, toll free hotline 1-800-482-1122; How To Save Money by Insulating your Home from the United States Department of Energy, Washington, D.C. 20461; SEED: Schoolhouse Energy Efficiency Demonstration and the film, "The Fourth R" and companion booklet from Tenneco Incorporated, Public Affairs Department, Box 2511, Houston, Texas 77001.
All of the above are free of charge.

2. Steps in Lesson

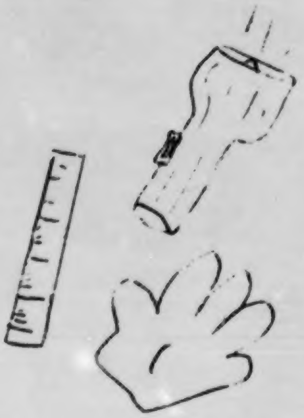
Objective #1: The students will gain insight into conservation of energy through use of insulation materials.

a. Have students bring fruit juice cans and insulating materials or use material from a classroom "resource box".
b. Introduce the lesson by asking: What is insulation? Which materials are better insulators? List on chalkboard in order of insulating properties as chosen by class.
c. Divide the class into groups of 3-4. Have each group obtain materials they will use.
   Group 1: No insulating material.
   Group 2: Styrofoam packaging material; measure thickness.
   Group 3: Newspapers; same thickness as styrofoam.
   Additional groups choose other insulating materials same thickness as styrofoam such as: cloth, fiberglass, insulating materials from a local contractor, plastic, glass, wood, aluminum foil, etc.
d. Each group prepares its juice cans. Place an ice cube in each can. Place all cans either in the sun or in the shade. Check the ice cubes at 15-minute intervals until the first ice cube is melted. Continue to check until all ice cubes are melted. Record the time it takes to melt each ice cube.
e. Discuss the following:
   -Which material served as the best insulator? The poorest? List in order of insulating properties.
   -Is good insulation important only in the winter when fuel is being used to heat the house? Explain.
   -What kinds of materials are used for insulating houses? Prepare a display of some of the more common ones.
   -What are the advantages of storm windows and doors?
   -How can room decorating (rugs, draperies) help in insulation?
   -What steps can be taken by the average homeowner to achieve better insulation?
   -If a well-insulated house saves money in fuel for heating and electricity for air conditioning, why are more new houses not better insulated?
   If you have an advanced class, you may wish to use Student Worksheet 27.7 rather than steps a, b and c.

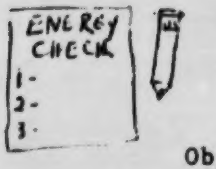
Objective #2: The students will look at a comparison of the insulating efficiencies of various materials.

a. Hand out Student Worksheet 27.8; have the students work in small groups to complete the activity. Discuss the results as a group.

Objective #3: The students will determine how insulation can save on utility bills.



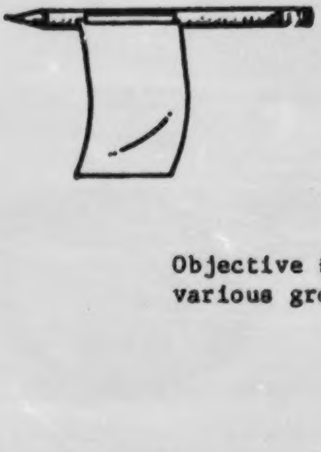
a. Hand out Student Worksheets 27.9 - 27.11. Give the students the following information on the check-list: Most Arkansans pay higher than necessary fuel bills because their homes do not use energy efficiently. Using this check list, you will discover where your home is wasting energy and what simple improvements can help reduce your utility bills. To find out how your home is wasting energy, first find out how your home is using energy. This means looking for ways in which heat escapes in the winter and enters in the summer. It means checking appliance usage and evaluating lifestyle. Several of the places you will be going will be dark and dirty, so you will need some old clothes, a flashlight, ruler, candle and gloves. Take along a piece of paper and pencil to take notes on your discoveries. Have the students fill in the check list at home, then disucss the results the next day in class.



b. Hand out Student Worksheets 27.12 - 27.13. Have the students fill in the answers individually, then discuss the results as a class.

Objective #4: The students will determine that draperies and curtains can prevent energy loss.

a. Build a cardboard "house" by taping a piece of plastic wrap across the open top of a cardboard box. Next, punch a small hole in one end of the box and slip a thermometer through it. On a sunny day, place the box on the sunniest window sill with the plastic front facing the sun. Record the temperature inside the box. After recording, shake down the thermometer. Now put a piece of cloth over the plastic window to simulate a window curtain or shade. Record the temperature inside the box. Ask the students: Is it different from the first time? What does this tell you about use of curtains and draperies?



b. Have the students build a draftometer and check for areas that might benefit from draperies.

-To make a draftometer: Cut a 5 inch by 10 inch strip of plastic food wrap. Tape it to a pencil. Blow the plastic gently and see how freely it responds to air movement.

-Have students test their home and schoolroom for air leakage by holding the draftometer near the edges of windows and doors. Why are drafts energy wasters? Look for dirt collected around doors and windows. What does it indicate?

Objective #5: The students will research methods of insulation used by various groups.

a. Divide the class into small groups. Assign or let each group choose one of the following to represent:
  - People of England during medieval times.
  - Mesa Verde Indians of the 13th century.
  - Alaskan eskimos of the 1800's.
  - Early Arkansas Indians such as the Bluff Dwellers, Quapaw, Osage, Caddo or Mound Builders.
  - The earliest white Arkansas settlers.
  - Modern day campers.
  - A denning or nesting animal of Arkansas.

b. Have the students research methods used by their particular group to insulate their dwelling places. Have them cover such areas as: insulating material, type of structure, insulating method, insulating efficiency and relationship of the insulation to the geographic area occupied by the group.

c. Each group should make an oral presentation of their findings that includes visual aids such as pictures, models, posters, etc.

Objective #6: The students will understand the meaning of R-values.

a. Hand out Student Worksheets 27.14 - 27.15. Have the students do the activity individually, then discuss the results in class.

b. Show and discuss the film "The Fourth R."

3. Evaluation

Have students study the booklets The Arkansas Energy Savings Handbook for Homeowners and How to Save Money by Insulating Your Home; then use the suggestions contained in the booklets to make decisions concerning the insulation of their future homes or the retrofitting of their existing homes. The students may construct models or make posters to illustrate their ideas. The models and/or posters may be displayed for the class, faculty or parents.

4. Follow-Up Activities

Invite a speaker from a commercial insulation firm.
Make a visit to a contractor, new home site or retail store to study types of insulation.
Have the students design an experiment to test the insulation value of various Arkansas woods (pine, oak, hickory) as compared to that of various Arkansas stones (limestone, sandstone, shale).
Have students evaluate the energy efficiency of their school, by making use of the methods described in SEED: Schoolhouse Energy Efficiency Demonstration.

TEACHER BACKGROUND INFORMATION

Source:

Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

Fuel requirements have grown larger as builders have relied less and less on the buildings themselves to insulate the space indoors. The buildings of a century ago with thick masonry walls and heavy slate roofs have been replaced by buildings with large expanses of single-pane glass and roofs that are thinly insulated. As a result, enormous volumes of fuel and electricity are required to make the indoor environment "comfortable." Energy supplies had been so abundant and low in price that it seemed unimportant that most of the energy purchased to heat and cool homes leaked into the outdoors.

Residental energy use accounts for about 15 percent of the total energy (including electricity) consumed in Arkansas (the national average is about the same). Over half the residential energy is used for space heating and cooling. Houses in Arkansas typically consume about 40 percent more fuel each year for heating and cooling than would be necessary if they were designed, insulated and built to use energy efficiently. Walls and roofs are inadequately insulated; wide expanses of glass permit heat loss; there are too many openings around doors, windows and chimneys. About twice as much heat and coolness escapes through the walls as would be the case with optimum insulation. An important savings can be made through a relatively small investment in increased insulation, by a more judicious use of glass as a building material, and by operating heating and cooling systems more efficiently. Any such investments typically pay for themselves in three to five years. Thereafter, the consumer saves money as well as energy.

Many energy-saving measures are possible in existing homes: adding insulation, installing storm windows, plugging leaks around windows and doors, maintaining more moderate temperatures, turning down the heat at night, shutting off unused rooms, and turning off the air conditioner on cooler days. Even without heavier insulation, energy consumption for heating and cooling existing houses can and is being reduced by about 20 percent, or half as much as in new houses.

The challenge is how to translate the new interest in conserving energy in both existing and new houses into a program of action. As energy prices increase, the incentives for action to save energy become even more attractive. The crux of the problem in the marketplace is that builders do not live in the structures they build. They sell or rent them, and it is the owner or tenant who has no direct voice in the design who pays the fuel and electricity bills. And the builders' incentives are to economize as much as possible on insulation, which is not seen anyway. The challenge has been partially met by the Arkansas Energy Reorganization and Policy Act of 1979, which granted the Arkansas Energy Office the authority to "promulgate reasonable rules and regulations for the purpose of implementing thermal and lighting efficiency standards for new building construction.

For existing structures, the Arkansas Energy Savings Tax Incentives Act of 1979 has provided a tax incentive to encourage energy conservation. A taxpayer can receive a state income tax deduction for "qualifying energy conservation expenditures." Such expenditures include insulation, furnace replacement burners, devices for modifying flue openings, ignition systems that replace gas pilot lights, storm or thermal windows or doors, clock thermostats, caulking and weatherstripping, motor or wind driven vents, attic fans and glass fireplace doors. A taxpayer may deduct from gross income all qualified energy conservation expenditures made during a tax year.

The national congress has also provided a tax incentive to encourage home energy conservation. This is in the form of a credit -- which is subtracted from total income tax owed rather than from gross income -- and may be claimed by a taxpayer who installed qualifying energy-saving components and materials.

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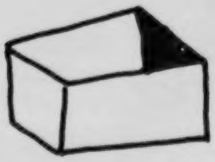
Student Worksheet

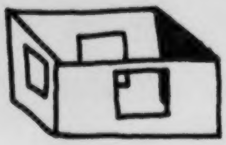
INSULATION

Use the following to conduct this experiment on insulation:
100 watt-light bulb in ceramic socket
Variety of insulating and non-insulating materials such as wood, aluminum foil, fiberglass, glass, newspaper, heavy cloth, etc.
Cardboard box with four openings cut in it
Masking tape
Watch
4 thermometers

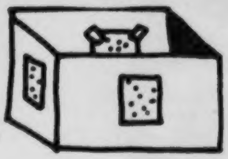
1. Cut the bottom of a box. Leave the top on.



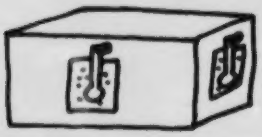
2. Cut windows on each of the 4 sides.



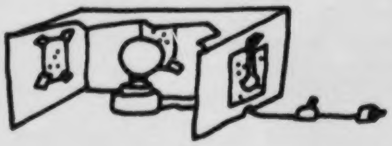
3. Tape 4 different insulating materials over windows on inside of box.



4. Tape a thermometer to the outside of each insulated window.



5. Place a light inside the box. Leave on for 5 minutes. Record the rise in temperature at each window. Compare differences.



6. Calculate the change in temperature for each material, using the tables below.

Materials

Temperature	WOOL	FOIL	FIBERGLASS	METAL	GLASS	PAPER
Before						
After						
Change						

7. Decide which would be the best insulating material. Explain your reasoning (use backside, if necessary).

Student Worksheet

INSULATION: WHICH IS BEST?

Using the tables calculate the answers to the following questions:

1. How many times more efficient as insulation are most woods commonly used as building materials than most stones?
2. How many inches of stone would be required to insulate as well as two inches of wood?
3. Is a woodpecker's nest in the heart of a 10-inch tree as well insulated as a bear's den inside a 3 foot thick rock?
4. How thick would the walls of the bear's den have to be to be better insulated than the woodpecker's nest?
5. How many times more efficient as insulation is wood than concrete? Than Steel? Than aluminum?
6. How many inches of concrete would be required to insulate a human dwelling as well as 2 inches of wood? How many inches of air space?
7. How many times less energy is required to manufacture one ton of lumber than an equal amount of steel?
8. What is the ratio of energy required to produce equal amounts of aluminum to steel? (State in lowest terms).
9. How many tons of lumber could be manufactured using the same amount of energy as it takes to manufacture one ton of aluminum?

TABLE 1

Thermal Properties of Various Building Materials, Per Inch of Thickness

Material	Thermal Conductivity (K)	Thermal Resistance(R)	Efficiency as an Insulator (Percent)
Wood	0.80	1.25	100.0
Air Space	1.03	0.97	77.6
Cinder Block	3.6	0.28	22.4
Common Brick	5.0	0.20	16.0
Face Brick	9.0	0.11	8.9
Concrete (Sand & Gravel)	12.0	0.08	6.4
Stone (Lime or Sand)	12.5	0.08	6.4
Steel	312.0	0.0032	.25
Aluminum	1416.0	0.00070	.06

TABLE 2

Energy Required to Manufacture Various Building Materials

Lumber-453 kilowatt hours (kwh)/ton (.9 metric tonne)
Steel - 3,780 kwh/ton
Aluminum - 10,160 kwh/ton

Source: National Forest Products Association

Student Worksheet

INSULATION: WHICH IS BEST?
ANSWER SHEET

The tables on Student Worksheet 27.8 are from the National Forest Products Association.

For purposes of easy comparison we have assigned wood a rating of 100 and calculated the appropriate values for the other materials in relation to that figure. Actual values for heat transfer resistance of materials can be found in handbooks such as the Handbook of Fundamentals, published by the American Society of Heating and Air-Conditioning Engineers.

Air space refers to spaces ranging from 3/4 to 4 inches in thickness.

1. 15 times

2. 30 inches

3. Yes

5. 15 times, 400 times, 1666 times

6. 30 inches, 1 1/2 inches

7. 8 times

8. 3 to 1

9. 2

Student Worksheet

HOME ENERGY CHECK

ATTIC

☐ **INSULATION** -- IS YOUR ATTIC PROPERLY INSULATED? Using the ruler, measure the depth of the insulation between your ceiling joists. The conversion chart on the first page of this brochure will tell you approximately what the R value is for the insulation in your attic. The recommended R value for Arkansas homes is R-38.

☐ **VENTILATION** --IS YOUR ATTIC PROPERLY VENTILATED? Attic ventilation is important to reduce the build-up of moisture in the winter and to reduce heat gain in the summer. The general rule of thumb for attic ventilation is one square foot of vent for every 300 sq. ft. of attic or one square foot for every 150 sq. ft. of attic if your attic does not have the proper moisture barrier. Better yet, consider installing a power ventilator.

LIVING AREA

☐ **INFILTRATION** -- IS YOUR HOUSE PROPERLY SEALED TO STOP AIR LEAKS? Cracks around windows and doors allow heat to escape in the winter and to enter in the summer. To test, hold a lit candle by the windows, door frames, air conditioning units, and attic doors. If the flame flickers, you need weather-stripping and caulking and perhaps even storm windows. Remember: an 1/8" crack around your door is equal to approximately a 6" diameter hole in your wall!

☐ **WALL INSULATION** -- ARE EXTERIOR WALLS PROPERLY INSULATED? Uninsulated walls can contribute greatly to your heating and cooling bills. To see if your walls are properly insulated, turn off the electricity in your home at the main circuit. Remove the cover plate from an electrical outlet on an exterior wall. By checking around the electrical box, it is possible to determine whether or not your walls are insulated. If insulation is present, additional insulation is not generally feasible or economical. For uninsulated walls the recommended R value is R-19.

☐ **FIREPLACE** -- IS YOUR FIREPLACE BEING USED EFFICIENTLY? While fireplaces contribute greatly to the aesthetics of a home, they can also lead to tremendous energy waste. Make sure the damper is closed when the fireplace is not in use. Also consider installing glass screens and outside ventilation to insure the most efficient use of your fireplace.

☐ **THERMOSTAT** -- IS YOUR THERMOSTAT SET FOR SAVINGS? Your thermostat should be set at approximately 68 degrees for winter heating (turn down five more degrees when sleeping). Air conditioning should not be set lower than 78 degrees in the summer. Remember: every degree you turn down your thermostat from 70 degrees reduces your heating bill by approximately 3%.

☐ **DRAPERIES** -- ARE YOU USING YOUR WINDOWS TO THEIR BEST ADVANTAGE? During winter, draperies and shades should be opened to allow sunlight in to help warm your home. At night, draperies should be closed in order to reduce heat loss. In the summer, draperies should be closed at all times in order to keep the sun's heat from entering your home.

Student Worksheet

HOME ENERGY CHECK

(Continued)

☐ **UNUSED ROOMS** -- ARE YOU HEATING AND COOLING AREAS YOU DO NOT USE? In this way you are paying to condition areas which will not be occupied.

KITCHEN

☐ **SEALS** -- ARE ALL APPLIANCE SEALS IN GOOD CONDITION? To test, close a dollar bill in the doors of your freezer, refrigerator, and oven. If the dollar bill can be removed with little resistance, the appliance is leaking energy and costing you a good amount of money. Replace the seal.

☐ **APPLIANCES** -- ARE MAJOR APPLIANCES BEING USED EFFICIENTLY? Major appliances use major energy. Use washers and dryers only when you have a full load. Some dishwashers contain an energy-saving cycle that allows the dishes to air dry. Major appliances should be used only during the morning and late evening hours or on weekends, when energy requirements are not at their peak. By using electricity during "off-peak" hours, you're saving your own and the country's energy.

☐ **LIGHTS** -- ARE EMPTY ROOMS KEPT LIT? Lighting empty rooms wastes energy. Lights should be used only on an as-needed basis, never just for decorative effect. Consider installing fluorescent bulbs wherever possible. Fluorescent lights use less energy but give off the same amount of light as ordinary incandescent bulbs.

HEATING AND COOLING SYSTEMS

☐ **HEATING AND COOLING SYSTEMS** -- IS YOUR HEATING AND COOLING SYSTEM WORKING AT PEAK EFFICIENCY? Clean or replace furnace and air conditioning filters at least once a month. Dirty filters make equipment work harder and use more energy. Have your unit serviced at least once a year. A professional inspection can help your furnace operate more efficiently and help to avoid major repair.

☐ **DUCTS** -- IS ALL DUCT WORK PROPERLY INSULATED? Without proper insulation, heating and cooling ducts in unconditioned spaced can rob your home of energy before it ever reaches you. All ducts going through unconditioned areas should be insulated to at least R-7.

THE OUTSIDE

☐ **WINDOWS** -- IS YOUR HOME EQUIPPED WITH STORM WINDOW/DOUBLE PANE GLASS TO REDUCE HEAT LOSS? Next to the attic, windows usually account for the greatest amount of energy waste. By installing storm windows or double pane glass, it is possible to cut the heat loss through the windows by as much as 50%. To reduce summer heat gain, windows should be shaded with overhang awnings or shade trees.

☐ **WEATHER STRIP AND CALUKING** -- ARE THE CRACKS IN YOUR HOME ALLOWING YOUR HARD-EARNED MONEY TO LEAK OUT? Weather-stripping and caulking are extremely important in sealing up your home. All cracks around windows, doors,

Student Worksheet

HOME ENERGY CHECK
(Continued)

electrical outlets, and outside facuets should be sealed. Infiltration drafts and cold spots cause higher utility bills!

☐ **DOORS** -- IS YOUR HOUSE EQUIPPED WITH STORM DOORS? Storm doors have been found to be effective in reducing winter heat loss and summer heat gain. For that reason it is profitable for you to keep tight-fitting storm doors on your home year round.

Source: Arkansas Energy Office

Student Worksheet

HOW TO CHECK YOUR HOME ENERGY CONSUMPTION

A simple calcualtion using the energy consumption recorded on your utility bills will show whether your home is energy efficient, or wasting money.

Take a minute to get out all your electric bills and gas bills for the past 12 months, and list them in a column -- add up the year's cost, and the year's consumption of kilowatts, or quantity of gas your family used.

To obtain a single figure showing total energy consumption perform these calculations:

1. Multiply the year's kilowatts times 3,412 to obtain the British thermal units, or Btu's consumed.
2. Take the year's total consumption of natural gas, and multiply the thousands of cubic feet times 1,030,000, to get the gas Btu's consumed.
3. If your home uses propane, multiply the gallons of propane consumed times 96,600 to get the propane Btu's consumed.
4. Add together all the Btu consumption figures.
5. Divide that sum by the number of square feet of housing that is heated and cooled.

That results in the number of Btu's per square foot consumed in a year's time.

Compare your energy consumption to this chart:

Under 50,000 Btu's wins you an A; you have an energy efficient home.

From 50,000 to 80,000 Btu's give you a B; you are trying.

From 80,000 to 120,000 Btu's gives you a C; this is the average consumption among today's homes.

From 120,000 to 175,000b Btu's gives you a D; you can do better and should give your home an Energy Check.

From 175,000 Btu's on up wins you an F; you are throwing away money.

Source: Arkanas Energy Office

Student Worksheet

HOW TO CHECK YOUR HOME ENERGY CONSUMPTION
(Continued)

	ELECTRICITY		NATURAL GAS		PROPANE	
Jan.	$	KWH	$	MCF	$	Gal.
Feb.	$	KWH	$	MCF	$	Gal.
Mar.	$	KWH	$	MCF	$	Gal.
Apr.	$	KWH	$	MCF	$	Gal.
May	$	KWH	$	MCF	$	Gal.
Jun.	$	KWH	$	MCF	$	Gal.
Jul.	$	KWH	$	MCF	$	Gal.
Aug.	$	KWH	$	MCF	$	Gal.
Sept.	$	KWH	$	MCF	$	Gal.
Oct.	$	KWH	$	MCF	$	Gal.
Nov.	$	KWH	$	MCF	$	Gal.
Dec.	$	KWH	$	MCF	$	Gal.
TOTAL	$	KWH	$	MCF	$	Gal.

KWH X 3,412 = BTUs

MCF X 1,030,000 = BTUs

GAL X 96,600 = BTUs

TOTAL BTUs

TOTAL BTUs	Divided by	TOTAL Sq. Ft.		BTUs/Sq. Ft./Yr.
	÷		=	

Source: Arkansas Energy Office

Student Worksheet

KNOW YOUR R-VALUES

On a cold day, what do you wear? You know a parka or quiltlike coat will keep you the warmest because such garments insulate best, preventing your body heat from escaping. But if you happen to get caught outside dressed in just a thin sweater, you could keep warm by jumping up and down to burn calories and generate more body heat.

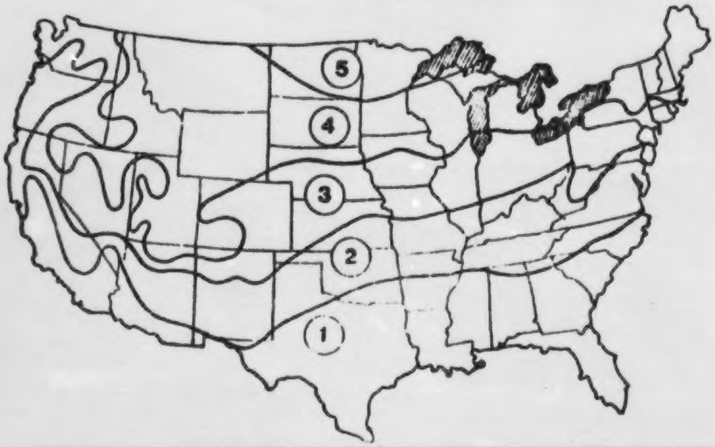
Well, the situation is exactly the same with your house. It needs insulation in winter for the same reason you do. The important question is: What's your house got on? A thin, threadbare sweater or a down filled parka? If your house is only "wearing a sweater" then your furnace will have to burn more energy to keep warm. It's a lot cheaper these days to buy your house that "down-filled parka" (insulation) than to feed your heating system more fuel. When buying insulation, it's important to understand R-values, because then you'll know just how heavy a "parka" to buy your home.

The effectiveness of insulation is measured in R-values. The higher the R-number, the more insulation value you get and the more money you eventually save. Imprinted on every batt or blanket of insulation or on every bag of loose insulation is its R-number.

The number of R's needed depends on where you live. Find your home-heating zone on the map and check the chart for the R-value you need in your attic floor, exterior wall and other house areas.

THE RIGHT R-VALUES FOR WHERE YOU LIVE

Heating Zone	Attic Floors	Exterior Walls	Crawlspace or Basement Ceilings
1	R-26	(R-Value of full wall insulation, which is 3-1/2' thick, will depend on material used. Range is R-11 to R-13.)	R-11
2	R-26		R-13
3	R-30		R-19
4	R-33		R-22
5	R-38		R-22



You can figure out how many square feet of insulation you will need by measuring in feet the length and width of the area to be covered, and multiplying the two dimensions. The answer will be the square footage of insulation material necessary.

Student Worksheet

KNOW YOUR R-VALUES
(Continued)

Insulation's value is in its resistance to heat loss. For that reason, it is necessary for you to decide the total R-value of your insulation, rather than the total number of inches. Six inches of one type of insulation may not be equal to six inches of another type. The following table can help you decide for yourself exactly what the R-value is in your home.

R-Value	APPROXIMATE THICKNESS				
	Fiberglass Batts or Blanket	Blown or Loose Fill			
		Cellulose	Fiberglass	Rockwool	Urea Foam
R-11	3-1/2"	3"	5"	4"	2-1/2"
R-13	4"	4"	6"	5"	3"
R-19	6"	5"	9"	7"	4-1/2"
R-22	7"	6"	10"	8"	5"
R-26	8"	7"	12"	9"	6"
R-30	10"	8"	14"	11"	7"
R-33	11"	9"	15"	12"	7-1/2"
R-38	12"	10"	17"	14"	9"

Answer the Following Questions:

1. Why is insulation measured in R-values rather than inches?

2. How many R's should residents of your area need for effective insulation?

3. What material on the chart offers the best insulation for the least amount of inches?
   The least insulation value?

4. How many square feet of living space does your home contain?
   Calculate the square feet of insulation you would need in your home for your area.

5. Name some ways, in addition to insulation, that you can prevent heat loss in the winter and heat gain in the summer in your home.

Student Worksheet

KNOW YOUR R-VALUES
ANSWER SHEET

1. Insulation's value is in its resistance to heat loss. Six inches of one type of insulation may not equal six inches of another type.
2. Depends on your area (map distinguishes between northern Arkansas and southern Arkansas).
3. Urea foam
   Fiberglass
5. Answers vary.
6. Caulking, weatherstripping, use of storm windows and doors.

LESSON #28

CATEGORY: Conservation

ENERGY TYPE: Gasoline

TITLE: Be a Featherfoot, not a Leadboot

GRADE LEVEL: 9-12

INFUSE WITH SUBJECT AREA:
Social Studies
Math

TIME NEEDED: Three periods

MATERIALS:
Featherfoot Film Kit
Booklets on conservation of gasoline

Featherfoot

OBJECTIVES:

1. The students will become aware of the amount of gasoline consumed by their families.
2. The students will investigate some of their own attitudes about automobiles.
3. The students will investigate the automobile attitudes of people other than their own families.
4. (Optional). The students will discover the relationship between energy supplies and automobile engine efficiency.
5. (Optional). The students will consider the feasibility of gasoline rationing.
6. The students will become aware of savings possible through conservation of gasoline.

TASK ANALYSIS:

The students should be able to watch a film and answer questions from that film; keep records of gasoline consumption; and do basic math computations.

PROCEDURE:

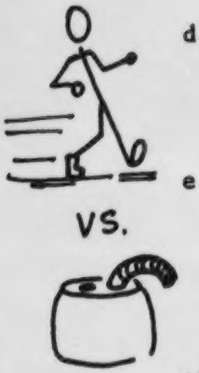
1. Preparation
   Duplicate Student Worksheets 28.9 - 28.15.
   Read Teacher Background Information (28.5 - 28.8).
   Order above-listed materials:
   Featherfoot Film Kit from the Arkansas Energy Office, 3000 Kavanaugh, Little Rock, Arkansas 72205, toll-free telephone number 1-800-482-1122 or the Arkansas Department of Education, Driver Education, Arch Ford Education Building, Little Rock, Arkansas 72201. Cost involved is return mailing of the film.
   Booklets that may be ordered from the same address are:
   Fill it Up, A Commonsense Guide to Saving Gasoline;
   Fill it Up: Tips on Carpooling; and the 198- Gas Mileage Guide.
   Other available booklets are:
   Tips for Energy Savers from Energy Conservation Now, Pueblo, Colorado 81009; and the conservation booklet from Mobil Oil Corporation, 150 East 42nd Street, New York, New York 10017.

2. Steps in Lesson
   Objective #1 The students will become aware of the amount of gasoline consumed by their families.

a. Hand out Student Worksheet 28.9. Discuss how to complete the sheet.

b. When data are brought to class the following week organize them into a matrix under headings such as subcompact, compact, full size, station-wagon, pick-up truck and/or other categories deemed appropriate (such as engine size or vehicle weight).

c. Discuss such questions as:
-What kinds of vehicles were most efficient? Why?
-Was this a meaningful experiment?
-How could it have been improved?
-Whose family gets the best mileage? The worst? Why?
-Is it a good idea for the Environmental Protection Agency (EPA) to report to the public the results of their mileage tests on new vehicles?
-What kind of vehicles will pupils buy when they are old enough?



d. Have the students keep a log of all trips made by automobile for two weeks. Separate lists into the following categories:
Those which were within walking distance.
Those which would have been very difficult to walk.
Those where walking was not feasible.

e. Discuss the following:
For a two-week period can you cut down on the trips within walking distance?
How much gasoline was used in the two-week period?
Calculate the number of gallons, the cost per gallon and the total cost of fuel.

Objective #2: The students will investigate some of their own attitudes about automobiles.

a. Hand out Student Worksheet 28.10. Discuss the questions on the sheet. If necessary use Student Worksheet 28.11 to help the students with question #5.

b. Hand out Student Worksheet 28.12. Have each student answer the questions individually, then discuss the answers given in class.

c. (Optional). Hand out Student Worksheet 28.13. Have the students work the sheets individually, then discuss in class.

Objective #3: The students will investigate the automobile attitudes of people other than their own families.

a. Divide the class into small groups; give each group a copy of Student Worksheet 28.14. Station the groups around the community to complete the survey.
If this is not possible, give each student a copy of the survey to complete with a parent after school.

b. Discuss the results of the survey. If you wish, write an article on the results for your school or community paper.

Objective #4: (Optional). The students will discover the relationship between energy supplies and automobile engine efficiency.

a. Read this to your class: A television news story stated that "An association of owners of Rolls-Royce automobiles is lobbying for special consideration for their gasoline needs in the event of a gasoline shortage. Their reason: they are unique, and their 5 mile-per-gallon "gas guzzlers" are an important element of the good life of America and should be maintained." The owners also expressed their willingness to pay a penalty tax of $500 to $1000 to offset their high use of energy.

Ask: How do you feel about this case of the large luxury car owners?

Have the students discuss the pros and cons of their case.

Ask: Can money replace the nonrenewable resource gasoline?

b. Check with your local big-car dealers to determine any changes in their automobiles since the oil crisis of 1973 in:
   - Weight of automobiles
   - Gasoline efficiency in miles-per-gallon
   - Sales volume
   - Advertising (efficiency versus luxury)

c. Survey small-car dealers to determine any change in the numbers of big-car owners who have traded in their "gas guzzlers" for small automobiles.

d. Have students do their choice of one of the following:
   - Write an obituary to a "gas guzzler."
   - Ask: "What will take the place of the large luxury car in the dreams of the people?" Write a poem on the new dream.
   - Write a class skit showing the last owner of a "gas guzzler" trying to buy gasoline.
   - Play a game filling in the blanks with one or two word endings. Student with the most words wins. For example: An automobile is saving energy when it is ____________ (parked, tuned-up, coasting, turned-off, etc.)

Objective #5: (Optional). The students will consider the feasibility of gasoline rationing.

a. Collect stories and pictures showing lines of cars at gasoline stations, then write a newspaper article about these lines and the reactions of the people waiting in them.

b. Survey gasoline supplies in your community and how they compare with supplies available a year ago.

c. Investigate previous attempts to ration gasoline in the United States. (World War II and in 1979).

   Evaluate the odd-even license number system of selling gasoline used in California, Florida and other states.

   Interview someone who can remember rationing during World War II.

d. Using all possible elements, devise a rationing plan on which the class can agree. (Probably impossible, which will be a good illustration of why politicians do not want to be involved in developing a plan). On the basis of your discussion, ask if the students think any plan could be entirely fair.

   Devise a system to beat the rationing plan the class developed.

e. Investigate the potential effects of gasoline rationing on the tourist industry and the economy of Arkansas.

   Discuss whether a tourist state should get a larger allotment in any national allocation plan.

   Discuss whether Arkansas, as a rural state, should get a larger allotment in any such plan.

f. Ask: How have the media (radio, television, newspapers and magazines) contributed to the shortage?

Objective #6: The students will become aware of savings possible through conservation of gasoline.

a. Have the students read the booklets on gasoline conservation, then discuss the material.
b. Utilize the film kit, "Featherfoot; The Arkansas Challenge," by having the students figure their Driving Efficiency Quotient as they watch the film. (See Teacher Background Information 28.7 - 28.8 for an example of the DEQ sheet included in the film kit). Have each student work the problems individually, then compare answers in class.
c. Hand out Student Worksheet 28.15. Have each student work the problems individually, then compare the answers in class.

3. Evaluation

Have the students do another chart on gasoline consumption, such as Student Worksheet 28.9, using energy saving techniques. Compare the two charts.

4. Follow Up Activities

Have students write a paper describing how their lifestyle would be affected during a period of gasoline rationing or shortage.
Have students investigate the dangers of carrying gasoline in cans in the trunks of automobiles.
Have the students outline the advantages of walking short distances rather than driving (energy conservation, parking, risk of accident, pollution, exercise, social aspects, environmental appreciation, economy, etc.). List the disadvantages (time consuming, inconvenient, small children at home, etc.).
Discuss the kinds of automobiles which have had the greatest impact on people's lives. (Model-T, vans, station wagons, campers, pick-up trucks, etc.).
Investigate life in Davis, California, a city in which automobiles are not allowed. Would this be possible in Arkansas? Where?
Investigate the changes in the life-styles of people following the development of the Model-T Ford by Henry Ford and developments in automobiles since. Discuss automobiles and: shopping centers, leisure activities, recreation, pace of life and eating habits.

TEACHER BACKGROUND INFORMATION

Sources:

Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

Arkansas Energy Office. Featherfoot, The Arkansas Challenge. Little Rock. 1980.

Regarding the energy used for transportation, the distance that separates home and commercial-industrial facilities is the crucial factor. Since World War II mushrooming suburban development has imposed an ever-greater need for the consumer to drive his automobile to work, shop or to accomplish almost any task. The elaborate circumferential highways encircling Little Rock, and the high-density traffic on them, illustrates how most urban Arkansans must travel simply to get to work and back home each day.

All forms of transportation account for nearly 30 percent of the total energy consumed in Arkansas. Nationally, about a quarter of the total energy used is accounted for by transportation. Arkansas' disproportionate use for transportation is likely due to its predominately rural and, thus dispersed, population. This translates to greater distances travelled to work, school, shopping and other destinations.

The greater opportunities for saving energy in transportation lie in more efficient automobiles, which account for well over half of the transport energy used in Arkansas. This means less powerful engines, and lighter and smaller cars. Cutting a car's weight in half typically halves fuel consumption. It can also mean using standard transmissions, omitting air conditioning and using better ignition systems. Obeying the 55 mile-per-hour speed limit, driving smoothly, cutting idling time, keeping tires properly inflated, and keeping the engine tuned all save energy. Ride-sharing, such as carpooling and vanpooling, can play a significant role in energy conservation.

In Arkansas, probably less than three percent of passenger trips are made via mass transit. Automobiles use most of the energy; therefore, we need to concentrate on improving their efficiency.

There is no cure-all to the problem of urban sprawl, but certainly planning the growth of urban areas to enable people to live in pleasant surroundings relatively close to their work and services must be part of the solution. Moving back to city centers might well be a constructive citizen response to the energy crisis that would keep our cities from dying a slow death as well. Programs are needed to revitalize our urban areas for people of all income levels and to build new work-oriented communities. With planning, new homes and places of work can be brought closer together. To be sure, most people will be living and working in existing buildings for decades. That is why improving the average mileage of automobiles is an essential element of any solution. It is not necessary for Arkansans to give up the family car. What is necessary is that the car go twice as far on a gallon of gasoline. And that the car, as often as possible, carry more occupants than merely the driver.

The electric car is often mentioned as an alternative, especially as a small vehicle to be used for trips within the urban area. An electric motor is more efficient than an internal combustion engine. An electric car will cut in half the energy used per passenger mile even if all the losses in generating electricity are included. Electric cars will shift air pollution from city streets to power plant sites. However, the introduction of electric cars will not necessarily require a significant addition of new power plants if these cars are recharged in periods of low demand, such as during the night.

Cars and trucks have been a major force in Arkansas' quality of life. Yet, certainly energy conservation, environmental and safety concerns are changing the motor vehicles' role in our everyday lives.

Persons in all fields have had to face a barrage of severe economic realities recently. For the Arkansas driver, maintaining a motor vehicle as fuel prices continue to rise, represents a special challenge. Driving is important to Arkansas, especially with respect to our work, vacationing, hauling goods and providing services. But, in the current economy, many factors threaten these activities. Vehicle expense ranks high among these factors.

There is something that can be done. Arkansas is actively promoting more efficient usage of vehicle fuels. By converting to vehicles with higher miles-per-gallon ratings, and by being aware of facts about efficient driving techniques, it is hoped that vehicle fuel consumption in Arkansas can be significantly and painlessly reduced. Savings can run into the hundreds of millions of dollars and gallons in the months and years ahead, without affecting our life style.

Arkansans of all income levels and from all areas of the State depend on their cars and trucks for daily travel. Some 1.4 million drivers put over 15 billion miles on their vehicles and use nearly 1.3 billion gallons of fuel each year.

We use enough fuel to fill 15 foreign built super tankers, each filled with 84 million gallons of foreign oil, representing a total annual oil bill of 890 million American dollars.

If each of us increased our own driving efficiency by only one mile-per-gallon, the total Arkansas savings would amount to 93.4 million gallons per year. This kind of savings represents 66.7 million dollars worth of foreign oil, money which could provide five thousand Arkansans with jobs.

A state-wide, one mile-per-gallon effort would also eliminate 178 thousand tons of pollutants from our air. That's enough tonnage to fill a train 18 miles long and needing 71 engines to pull it.

So, how far can driving-efficiently savings go?

TAKE A LOOK:

YEARLY IMPACT

	Gallons	Dollars	Jobs
Arkansas	93.4 million	66.7 million	5 thousand
Nationally	8.9 billion	6.4 billion	489 thousand

Savings like these are indeed significant. They are in Arkansas' interest and in our nation's interest. Energy conservation that benefits all of us can result from the accumulation of just one mile-per-gallon.

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DEQ is your Driving Efficiency Quotient. It reflects what you know about driving habits that use fuel efficiently. To determine your DEQ, answer these questions during the movie.

1. Which of these situations produces the worst gas mileage.
_____A. Jackrabbit starting
_____B. Driving over 55 miles per hour
_____C. Idling
_____D. Unnecessary use of air conditioning
_____E. Going without a tune-up when you need one Score:_____

2. Your're parking your car on a cold winter day. You're only going to be gone 5 minutes.
_____A. Turn the engine off because a cold engine doesn't waste that much gasoline.
_____B. Leave the engine running because driving with a cold engine wastes more gas than idling with a warm one.
_____C. Turn the engine off because the engine won't actually get cold.
_____D. Leave the engine running because it takes extra gas to warm up the heater. Score:_____

3. What's the best way to avoid wasting gas on acceleration?
_____A. Stay even with the traffic around you.
_____B. Depress the accelerator pedal no more than half way.
_____C. Put light pressure on the brake as you start out to avoid excess acceleration.
_____D. Apply accelerator pressure evenly. Score:_____

4. Tailgating wastes gasoline.
_____ True
_____ False Score:_____

5. In the movie which driver has a gas-wasting habit?
_____A.
_____B.
_____C.
_____D. Score:_____

6. What's causing the mileage variation you see in the movie?
_____A. The car needs a tune-up.
_____B. The accelerator is moving in a way that doesn't affect the speedometer.
_____C. The carburetor is dirty.
_____D. Gusts of wind.
_____E. All of the above. Score:_____

7. If you travel at 70 miles per hour, rather than 55, how much sooner will you reach a destination 8 miles away?
_____A. 5 min.
_____B. 4 min.
_____C. 3 min.
_____D. 2 min.
_____E. 1 min. Score:_____

8. Using a single-viscosity oil like 30 weight will give better gas mileage than using a multi-viscosity oil like 10W-30 or 10W-40.
_____ True
_____ False Score:_____

9. Do each of these items affect gas mileage?

A. Spark plugs _____ yes _____ no
B. Ignition timing _____ yes _____ no
C. The air filter _____ yes _____ no
D. Carburetor adjustment _____ yes _____ no
E. Brake adjustment _____ yes _____ no
F. Headlight alignment _____ yes _____ no
G. Wheel alignment _____ yes _____ no
H. Wheel balance _____ yes _____ no
I. Tire Pressure _____ yes _____ no
J. Transmission bands _____ yes _____ no

Score:_____

10. In each of the five parts of the movie test drive, is the driver saving gas or wasting gas?

A. _____ saving _____ wasting
B. _____ saving _____ wasting
C. _____ saving _____ wasting
D. _____ saving _____ wasting
E. _____ saving _____ wasting

Total Score for 10:_____
GRAND TOTAL _____

What your DEQ Grand Total means:

100-150 — You're a Featherfoot - at least you are if you put your knowledge of gas-saving driving techniques to work.

50-100 — You're Average. While you are not tremendously wasteful, you could probably get up to 30% better gas mileage by changing some driving habits.

nder 50 -- You're a Jackrabbit. Or at least you probably have a number of bad driving habits that waste fuel. According to the Federal Government's Office of Energy Conservation and Environment, you can probably increase your gas mileage by as much as 50% by using Featherfoot driving techniques.

Student Worksheet

I'M WILLING TO CONSERVE - BUT MY WHEELS???

> "This country has more licensed drivers than registered voters."
>
> Denis Hayes

Transportation, the means by which we get from one place to another, has become so important in our daily lives that 42 percent of all energy used in the United States goes either into manufacturing transportation vehicles or making them run.

Most of us are not aware of just how much it costs to drive a car. One expense we frequently have to share is the amount of gasoline it takes to fill the tank. So for the next couple of weeks keep a record of the amount of gas it takes to operate your family car(s).

To start the record, go to the filling station and fill the car's gas tank. Then keep track of all gasoline purchases for a week or more.

Date	Gallons of fuel	Odometer Reading	Miles	Miles-per Gallon	Price per Gallon
	FULL		XXX	XXXXX	

Answer the following questions:

1. How many gallons of gasoline did your family use in one week?
   What was the total amount spent for gasoline in this week?
2. Using the amount of money spent for gasoline in one week, calculate the possible amount spent for gasoline per year for your family.
   How does this compare to your family's total income?
3. Calculate the amount of savings possible per week if your family carpooled with another family. Two other families.
   How much savings would this be a year?

Source: Arkansas Energy Office

Student Worksheet

RESOURCE ALLOCATION TO THE AUTOMOBILE

A day or two ago you started keeping a record of the amount of gasoline used in the family's car. Toward the end of the school year you may be asked to again keep a record of how much gasoline it takes for your car to operate. In the meantime let us consider some other aspects of the automobile. The earth contains only a limited amount of minerals (finite supply) available for man's use, therefore, let us consider the massive resource allocation dedicated to making our "wheels".

Many of you are or will soon be involved in driver-education. Therefore you have some important decisions to make that not only affect you, your family and friends, but the way our resources are to be used in the near future.

1. Do you think you are going to HAVE a car? If so, why?
2. Do you think that the car is going to make you feel more important?
3. If you feel you must HAVE a car, do you think you are responsible enough to walk when it is feasible and to question the need for driving just for the sake of driving?
4. Are you ready to question the impact that driving has on your community?
5. Now list all the industries and economic activities that you think are connected to the automotive industry. Be specific. For example, advertising, drive-in movies, etc.

6 Describe your feelings if someone gave you a car today. Do this using: Pictures, poetry, drama, song, or any other media you choose.
Using the same medium describe your feelings about the car one year later.

Source: Arkansas Energy Office

Student Worksheet

ARE WE A DRIVE-IN SOCIETY?
How has the car influenced our culture?

	1870's No Cars	1980's Cars Readily Available
1. Means of Transportation		
2. Structure of urban areas		
3. Dating behavior		
4. Energy consumed for transportation		
5. Occupations		
6. Structure of houses		
7. Advertising		
8. Education		
9. Seasonal foods		
10. Theaters		
11. Banks		
12. Restaurants		
13. Health		

Add any other areas that you feel have been greatly influenced by the automobile.

Student Worksheet

YOU AND THE PRICE OF GASOLINE

As demand for energy increases, the price of energy will probably increase also. This price rise will happen if the supply of energy remains the same or grows more slowly than the demand for energy.

In most nations of the world outside of North America, gasoline costs 2 to 3 times as much as in the United States. What is the price of gasoline in your community now? ______________

1. List five different ways your family uses a car.

2. Which of these uses of the car would your family stop if the price of gasoline rose to:
   $1.50
   $2.00
   $3.00
   $5.00

3. At what price would your family stop using a car?

4. If your family were very much wealthier than it is, would your decisions be different?

5. If your family were very much poorer, would your decisions be different?

6. What factors, other than price, influence how your family uses the car? For example, the nearness to public transportation.

Source: United States Department of Energy

Student Worksheet

THERE ARE OTHER WAYS TO GET FROM HERE TO THERE

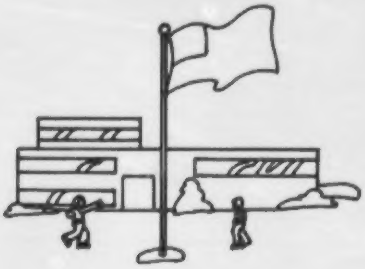
With your house as the starting point in each case, talk with your family about the way to get to each destination listed below and write in the space provided (1) the distance in blocks or miles (2) another way of getting there other than in the family car and (3) the time in minutes or hours the other methods would take.

SHOPPING CENTER

TOWN MALL
BANK

1. ______________________
2. ______________________
3. ______________________

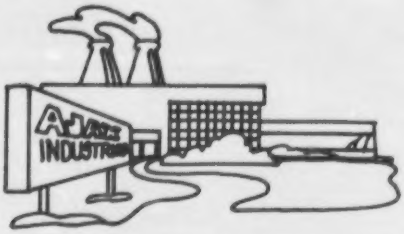
YOUR SCHOOL



1. ______________________
2. ______________________
3. ______________________

YOUR HOUSE

PARENT'S PLACE OF BUSINESS



1. ______________________
2. ______________________
3. ______________________

FAVORITE RESTAURANT

1. ______________________
2. ______________________
3. ______________________

FRIEND'S HOUSE

1. ______________________
2. ______________________
3. ______________________

Source: United States Department of Energy

Student Worksheet

REPORTER ON THE STREET CORNER

1. SURVEY

DIRECTIONS: Either with a group from your class or with a parent after school, you are going to observe traffic "where it's happening." Take this form along, spend 10 minutes at a busy corner, and count the items and events on this sheet. Later, you will put your figures together with those of others in your class to determine some action you can take. Use a checkmark for each of the following you see in 10 minutes.

HOW MANY:

large cars with 4 or more doors: ______________________________
small "compact" cars: ______________________________
cars less than 2 years old: ______________________________
"driver only" cars: ______________________________
buses: ______________________________
trucks: ______________________________

2. INTERVIEW

DIRECTIONS: Interview three people you know who own cars. First, describe the car as large (8-cylinder, 4-door, van or truck) or small (6 cylinder, compact or sub-compact.) Then ask them their reasons for purchasing the kind of car they did, how many miles a week they drive, and how many miles per gallon of gasoline they get. As a final question, ask them if they believe there is in fact an energy shortage in this nation.

	Type of Car	Why that size Purchased	Miles Per Week	Miles Per Gallon
Owner 1/Energy shortage? _____ yes _____ no				
Owner 2/Energy shortage? _____ yes _____ no				
Owner 3/Energy shortage? _____ yes _____ no				

DRIVING TIPS:

1. Observe the 55 mph speed limit
2. Avoid sudden starts and sudden stops
3. Follow a program of regular car maintenance: oil changes, tune-ups, and so forth.
4. Use your air-conditioning sparingly
5. Avoid idling the motor for long periods of time.
6. Form car pools if possible; bicycle and walk.
7. Use public transportation for commuting.
8. Purchase energy-efficient cars.

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Source: United States Department of Energy

Student Worksheet

$AVE DOLLAR$

1. Alexander had the tank of his car filled with gasoline and noted that the odometer read 14593. The next time he stopped for gasoline it required 4 gallons to fill the tank and the odometer read 14817. How many miles did the car average per-gallon of gasoline?

2. If Helen travels from Texarkana, Arkansas, to West Memphis, Arkansas, a distance of 270 miles, and her car averages 15 miles-per-gallon of gasoline, how many gallons are required to make the trip? How many gallons would be required if her car averaged 22 miles-per-gallon? What would the cost be for each one, if gasoline were $1.20 per-gallon?

3. How far can a car go on a tankful of gasoline if it averages 14 miles-per-gallon and the tank holds 18 gallons? How much farther could it travel if instead it averaged 22 miles-per-gallon? If it averaged 30 miles-per-gallon?

4. Correct tire inflation can save the average driver up to 50 gallons of gasoline a year. How much savings is this with gasoline at $1.20 per-gallon?

5. Regular tune-ups can save the average driver 175 gallons of gasoline a year. How much savings is this with gasoline at $1.20 per-gallon?

6. Driving at 70 miles-per-hour can take approximately 25 percent more gasoline per-mile than driving at 50 miles-per-hour. Assume that, on a 300 mile trip, while travelling at 50 miles-per-hour, your car consumed 20 gallons of gasoline. How much more would it consume if you traveled at 70 miles-per-hour? How much more would this cost if gasoline were $1.20 per-gallon?

7. Gerald Ford, when President, asked the automobile manufacturers to produce automobiles that would average 20 miles-per-gallon. Average mileage was 13.7 miles-per-gallon. The average car travels about 12,000 miles in the United States and about 14,000 miles in Arkansas per year. How many gallons are needed if your car averages 13.7 miles-per-gallon? What is the gasoline cost for each if gasoline is $1.20 per-gallon? How much would you save in a year if your car averaged 20-miles-per-gallon instead of 13.7? How much would you save in a year if your car averaged 30 miles-per-gallon rather than 13.7? Calculate these questions for both the United States and Arkansas.

8. There are about 100 million registered automobiles in the United States. How many gallons of gasoline would be saved if all automobiles got 20 miles-per-gallon? 30 miles-per-gallon? (You have already calculated how much would be saved by one automobile above). How much money would be saved in the United States with gasoline priced at $1.20 per-gallon?

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Source: West Virginia Department of Education

Student Worksheet

$AVE DOLLAR$
ANSWER SHEET

Some time may need to be spent teaching students to compute miles-per-gallon.

Many more problems can be discussed. Two pamphlets which are helpful are the 198- Gas Mileage Guide for New Car Buyers and Don't Be Fuelish, published by Energy Conservation and Environment, United States Department of Energy, Washington, D.C. 20461. Obtain free copies from Fuel Economy, Pueblo, Colorado 81009.

1. 6 miles-per-gallon

2. 18 gallons
   12.3 gallons
   Cost for 18 gallons: $21.60
   Cost for 12.3 gallons: $14.76

3. 252 miles
   144 miles
   288 miles

4. $60.00

5. $210.00

6. 5 gallons
   $6.00

7. At 13.7 miles-per-gallon: United States: 876 gallons
   Arkansas: 1022 gallons
   United States: $1041.20;
   Arkansas: $1226.40
   At 20 miles-per-gallon: United States: $ 321.20
   Arkansas: $ 386.40
   At 30 miles-per-gallon: United States: $ 561.20
   Arkansas: $ 666.00

8. At 20 miles-per-gallon: 27,600,000,000 gallons
   At 30 miles-per-gallon: 47,600,000,000 gallons
   At 20 miles-per-gallon: $32,120,000,000.00
   At 30 miles-per-gallon: $56,120,000,000.00

LESSON #29

CATEGORY: Conservation

TITLE: There's Savings in Numbers

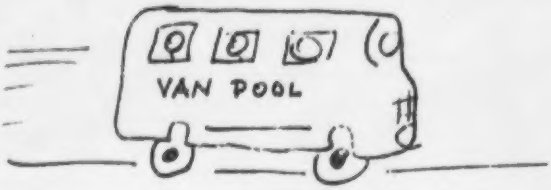
INFUSE WITH SUBJECT AREA
Social Studies
Math

MATERIALS:
None

ENERGY TYPE: Gasoline

GRADE LEVEL: 8-12

TIME NEEDED: Two periods



OBJECTIVES:

1. The students will examine energy usage in various modes of transportation.
2. The students will examine the role of mass transit in fuel conservation.
3. The students will observe how to conserve energy and save money while planning a simulated trip.

TASK ANALYSIS:

The students should be able to do basic math computations.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 29.5 - 29.6.
   Read Teacher Background Information (29.4).

2. Steps in Lesson
   Objective #1: The students will examine energy usage in various modes of transportation.

   a. Hand out Student Worksheet 29.5. Have the students do the activity described on the sheet.
   b. Hand out Student Worksheet 29.6. Have the students complete the sheet individually, then compare answers.

   Objective #2: The students will examine the role of mass transit in fuel conservation.

   a. Discuss with students the types of public transportation or mass transit systems available to United States cities (bus, subway, train, etc.). It has been suggested that through greater use of these, private citizens would use less fuel. Have the students discuss these questions:
      -List the fuels that would be saved.
      -What, if any, new fuels could be used?
      -What jobs might be lost?
      -What new jobs would be created for these new transportation systems.
      -Economically, would it be beneficial to adopt a mass transit system in place of the present auto-dominated one?

- How can carpooling and vanpooling contribute to conservation efforts.
- Would there be a sufficient reduction in pollution to warrant this change-over?

b. Discuss with the students the feasibility of mass transit in Arkansas. Have them prepare lists of why or why not they feel mass transit has a future in Arkansas.

c. If you wish, share the material found on Teacher Background Information (29.4) with the students.

Objective #3: The students will observe how to conserve energy and save money while planning a simulated trip.

a. Have the students go through all the formalities of planning a hypothetical trip to someplace in Arkansas. Let them choose the trip site, either one quite a distance away or the one they are most interested in.

b. Begin with a general outline of information needed. For example: how many days will the trip last? How will the class travel? How will the class earn the money to go? When is the departure date?

c. Have the students take into consideration items such as the following: (Encourage students to think of other factors that should also be considered).
- Which way is the most economical way to travel: plane, train, bus, car or van? Which way will best conserve energy and time?
- Plan a budget, including gasoline, food, lodging and miscellaneous items.
- Plan the trip itinerary from beginning to end. What are the best routes? Which routes would save gasoline? Which route is the most scenic?
- Make lodging arrangements. Which is the least expensive? Which is best located for the activities planned? Would camping be a possibility?
- Set up a correspondence committee to write to travel bureaus and automobile clubs for information. Write to different Arkansas counties for information.
- What kind of equipment is needed? Luggage? What do students take for personal needs? How will the amount of gear taken affect the cost of the trip?
- Plan the actual visit, including the time schedule. How much money is needed for the day's activities? How much gasoline will be consumed at what price?

3. Evaluation

Evaluate the plans set up by the students for their hypothetical trip.

Check answers to student worksheets

4. Follow-Up Activities

Have each student keep a journal of all his/her family's uses of transportation (including the family car) for one week.

Have students inventory local traffic patterns by stationing them at particular points during particular times of the day, and have them gather information such as number of vehicles passing that point, types of vehicles (whether car, truck, station wagon, taxi, bus, etc.), whether commercial or domestic, number of passengers, size of vehicle, etc. They may also survey to find the approximate number of cars in the community, average number and type per family, number of commercial vehicles operating within the community, etc. The students will be interested in time and places of heaviest traffic, ratio of cars to trucks, parking facilities, pollution, traffic jams, public transportation facilities and use, available railway systems, etc.

TEACHER BACKGROUND INFORMATION

Source:

Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

All forms of transportation account for nearly 30 percent of the total energy consumed in Arkansas. Nationally, about a quarter of the total energy used is accounted for by transportation. Arkansas' disproportionate use for transportation is likely due to its predominately rural and, thus dispersed, population. This translates to greater distances travelled to work, school, shopping, and other destinations.

Just about all Arkansans commute by automobile. Mass (public) transportation, such as buses or trains, is generally either unavailable or inconvenient. Mass transit patronage has declined in recent decades. Many policy planners have assumed this decline could be reversed, and that substantial numbers of commuters could be brought back to mass transit if attractive service were provided. But the automobile has easily resisted all challengers because, from the user's viewpoint, the automobile is a superior form of transportation: It takes a person where and when he wants to go and usually by the fastest, most direct route. It does cost the user more than mass transit but, given our affluence, almost everyone can afford an automobile. In Arkansas, with its dispersed pattern of population, it seems unlikely that any economically feasible form of mass transit will be capable of luring appreciable numbers of people out of automobiles (the exception to this may prove to be vanpooling, since mass transit is not practical or feasible in most areas of Arkansas).

Failures to revitalize mass transit are disappointing to many, but need not be viewed as especially discouraging from the perspective of energy conservation. Actually, mass transit's potential contribution to solving the energy dilemma is rather minimal. This is due to a generalization referred to as the "Law of Large Proportions," which states: "The biggest components matter most." To change something (such as energy use) within a system, attention must be concentrated on its largest components. A small improvement in a major component brings greater changes than a large improvement in a minor component. The application of this law in passenger transportation is particularly apt due to the enormous difference in the relative sizes of the two components. In Arkansas, probably less than 3 percent of passenger trips are made via mass transit. Automobiles use most of the energy; therefore, we need to concentrate on improving their efficiency.

Student Worksheet

TYPICAL TRANSPORTATION ENERGY EFFICIENCIES

MODE	BTU PER PASSENGER-MILE
Passenger	
Intracity	
Bicycle	200
Rail transit	2600
Bus transit	3000
Automobile	6700
Intercity	
Bus	1500
Railroad	2700
Automobile	3100
Airplane	7700
	BTU PER TON-MILE
Freight	
Pipeline	450
Railroad	670
Waterway	680
Truck	2800
Airplane*	42000

*Overstated since much freight is shipped on planes which would be carrying passengers in any case.

Source: Oak Ridge National Laboratory

Divide the class into four groups entitled:

1. Automobiles
2. Buses
3. Trains
4. Airplanes

Assign each group the responsibility to examine carefully the data concerning its mode of transportation. Each group should also compare the efficiency of its mode with the other three.

Each group should select a spokesperson who will explain, as clearly as possible, why certain vehicles are more energy consumptive than others. The spokesperson should also report and defend the group decision as to whether "its type" of transportation should increase or decrease in the years ahead.

Each group should determine what geographic areas of Arkansas its mode of transportation offers the most promise in, and why.

Student Worksheet

ENERGY AND EFFICIENCY IN TRANSPORTATION

Kind of Transportation	Miles Traveled	Number of Passengers	Gallons of fuel	Gallons per Person	Miles per Gallon
1 plane	500 miles	360	3,911		
1 car	500 miles	4	25		
1 van	500 miles	12	30		
1 train	500 miles	360	1,238		

Complete the above chart by:

1. Figuring how much fuel each person uses when traveling by plane, train, car and/or van.
   Formula: gallons divided by number of people will give you the gallons per person.
2. Figuring how many miles per gallon each of the means of transportation averages.

3. Deciding which means of transportation is most efficient ________________.

In the first 20 days of the 1980-81 school year, a school system had 46 regular bus runs, drove a total of 57,300 miles and used 12,733 gallons of gasoline. The buses are 66 passenger buses, and most of them are full making an average of 60 students per bus.

1. How many miles are driven daily?________________________________
2. How many students are transported per day?________________________
3. How many gallons of fuel are used per day?________________________
4. What is the average miles per gallon of gasoline?__________________

Answer the following questions:

1. How many miles per gallon do you get in your car?__________________
2. Normally when you are going to school or work how many passengers do you see in each car?__________________
3. In terms of getting from here to there what are the advantages of mass transit?

4. What are some arguments against mass transit in Little Rock or any of the other Arkansas cities.

5. When given the choice of driving your own car or going by bus, what would be your selection? Why?

Student Worksheet

ENERGY AND EFFICIENCY IN TRANSPORTATION
ANSWER SHEET

Kind of Transportation	Gallons per Person	Miles per Gallon
1 plane	10.8	.13
1 car	5.0	20.0
1 van	1.4	17.0
1 train	3.4	.4

3. Van

1. 2865 miles
2. 2760 students
3. 636.6 gallons per day
4. 4.5 miles per gallon

LESSON #30

CATEGORY: Conservation

ENERGY TYPE: All

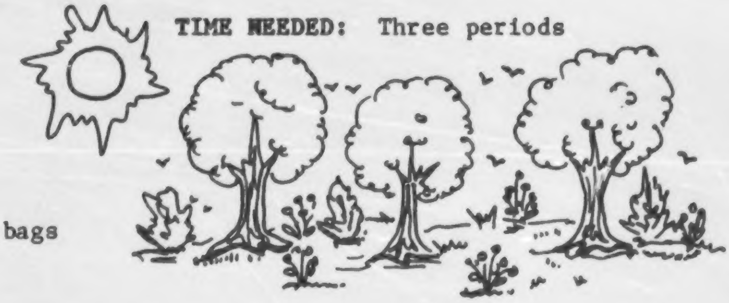
TITLE: Energy and Our Environment

GRADE LEVEL: 10-12

TIME NEEDED: Three periods

INFUSE WITH SUBJECT AREA:
Science
Social Studies

MATERIALS:
Optional:
1 tape recorder
5 white muslin collecting bags



OBJECTIVES:

1. The students will look for energy-related environmental changes in their own community.
2. The students will realize the effects on Arkansas' environment of its own industries, as well as those of other states.
3. The students will understand that conflicts over energy and environment will involve trade-offs in their resolution.
4. The students will become familiar with environmental impact statements.
5. The students will understand that transportation and transmission of energy have an environmental impact.

TASK ANALYSIS:

The students should be able to do independent research; be able to work in groups to present reports; and be able to read material, then answer questions on that material.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 30.7 - 30.14.
   Read Teacher Background Information (30.6).
   Gather above-listed materials.
   (Optional). Arrange for environmental impact speaker and/or field trip to public hearing.

2. Steps in Lesson
   Objective #1: The students will look for energy-related environmental changes in their own community.
   a. Do one of the following exercises:
      -Ask the students to look for and list any changes in their environment as a result of people's use of energy. Make a class list of these changes. Divide this list into the following categories:
      Search for energy
      Energy supply to school, home, or community
      Energy use
      Waste disposal

-Divide students into 5 groups, one representing each of the major human senses: sight, touch, hearing, taste, and smell. Ask each group to go on a "pollution search" attempting to identify the various kinds of pollution to which the sense they represent is or might be particularly vulnerable; for example, human litter in the forest (sight) or excessive auto exhaust on a crowded urban street (smell). One week might be spent with time both in and outside of school in "searching". At the end of the period of "search" time, have the students meet in their groups and organize their information for a class presentation. In there searching, the students may find examples of pollution that do not relate to the particular "sense" they represent. With all students participating, add any additional examples of pollution the students identified, adding these according to the appropriate category. Create a master list of kinds of pollution according to the senses represented.

PHYSICAL SENSES	POLLUTION
Sight	Litter
Touch	
Hearing	
Taste	
Smell	

There may be ways each of these kinds of apparent pollution can be changed into useful forms of energy. Do an analysis of those that might possibly be converted to usefulness; those that apparently could not. Think of ways to reduce or eliminate those not useful in another form. Make a plan for implementation of proposed ideas.

b. Have the students do their choice of one of the following:

-Draw or collect a series of cartoons depicting the effect of energy use on the environment.

-Write a speech for the governor which he/she can use to address the state legislative branch on the effect of energy use on Arkansas' environment.

-Write an environmental prayer which expresses your perceptions of the effect of energy use on the environment.

-Describe the differences in environmental results between the ways the Indians of Arkansas used energy and the ways energy is currently used by the residents of Arkansas.

-Write a research paper which compares the environmental conditions of these two states: Arkansas and New York or California.

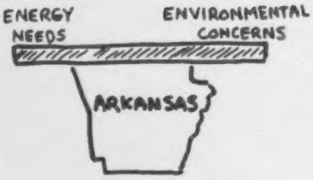
-Visit a busy freeway, pedestrian overpass, bridge, or industry which is mechanized. Note the noise level before going to the location where the noise is loudest. Stay there several minutes, recording the noise on a tape recorder. Repeat the exercise in a quiet rural area. Return to an area with an "acceptable" noise level. What are some noticeable differences in types of activities? Listen to the recording at school. Try to identify the sounds. What solutions can be suggested for reducing or eliminating some of the noise?

Objective #2: The students will realize the effects on Arkansas' environment of its own industries, as well as those of other states.

a. Have the students do any number of exercises found on Student Worksheet 30.7; either individually or as small groups. Have them present their findings to the class using visuals such as posters, charts, slides, etc.

b. Hand out Student Worksheets 30.8 - 30.10. Have the students read the material and answer the questions individually; then discuss the answers as a group.

Objective #3: The students will understand that conflicts over energy and environment will involve trade-offs in their resolution.



a. Hold a class discussion on what students feel is the meaning of the term "trade-off". (When a person or group chooses one good instead of another, they are making a trade-off -- that is they are trading off less of one thing for more of something else. Society has to make trade-offs too, e.g., between its need for more energy and its desire to preserve the environment. Essentially this involves comparing the various costs and benefits of each of the alternatives. It also involves determining how these costs and benefits will affect different groups within the economic system). Have the class make a list of trade-offs that have occurred in their own community.

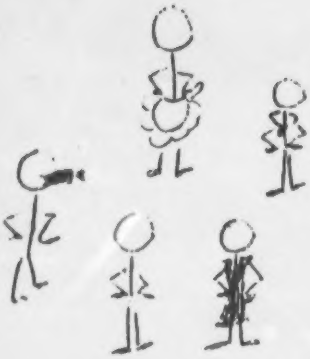
b. If you wish, share the material found on Teacher Background Information (30.6) with the students.

c. Have the students do one of the following exercises:

-Propose for discussion a situation in which an oil company wishes to explore for oil in the Ouachita National Forest or for natural gas in the Buffalo River area. Environmentalists try to stop the exploration on the grounds of destruction of wildlife habitat. Divide the class into two groups: environmentalists and oil company representatives. Have the two groups choose a student to act as a "forest supervisor" to arbitrate the discussion. Have each of the groups meet to prepare their case for presentation (speeches, charts, photographs, etc.).

Call a meeting of the two groups with the forest supervisor; let each group give its presentation. Follow this with a question-answer period. Let the two groups meet to discuss any compromises or trade-off proposals they might suggest or be willing to accept. See if a trade-off can be arranged.

-Select locations for three new electrical generating plants in Arkansas. Establish their exact sites. Discuss the characteristics of the fuel to be used in the plants. Discuss the transportation problems related to fuel and waste; also any other environ-



mental impacts that might be expected.

What might the reactions to each site be from:

- Banker
- Homemaker
- Industrialist
- Conservation club president
- Hospital manager
- Realtor
- Supermarket owner

Have students role-play possible responses from these various concerned citizens. Ask students to disucss their own reactions to each site.

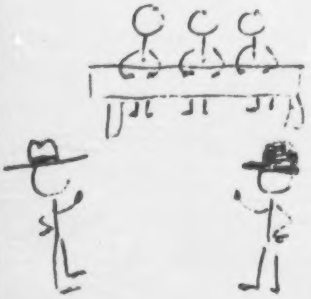
Objective #4: The students will become familiar with environmental impact statements.

Have students prepare environmental impact statements (EIS) according to guidelines suggested by the Environmental Protection Agency (EPA). The completed statements are then reviewed at a simulated public hearing held by the agency that wrote the statement.

As a class, study Student Worksheet 30.11 on preparing an EIS. Divide the class into teams of 3 - 5 students each. Ask each team to prepare an EIS for the proposal from the data provided on Student Worksheet 30.12. After the students have completed their EIS reports, the documents should be compared. Ask the students to discuss:

-How the statements differ in their assessment of the significance of the environmental impact, the alternatives they propose, and the evaluation of the short- and long-term benefits of the proposal.

-Whether each group considered the project's impact differently. Whether you might have expected all the groups to reach the same conclusion. Why or why not?



Select one member from each of the teams to serve on a simulated Department of Ecology panel which is holding public hearings to receive comments on the prepared EIS. In this hearing, panel members will question the consultants who prepared each EIS to clarify ambiguities or conflicts in conclusions. Students serving on the panel will have the benefit of participating in the process of writing the EIS. Once on the panel, however, they should no longer speak as if they had prepared the statements. They are now "respected citizens" questioning consultants about the EIS they have prepared. Another group of students might want to assume the role of interested citizens for the purpose of testifying at the hearing.

Objective #5: The students will understand that transportation and transmission of energy have an environmental impact.

a. Discuss the following:
   - Contrast the economic and environmental impacts caused by the transportation of coal, oil, natural gas or nuclear materials by:
     pipeline
     truck
     railroad
     ship
   - Describe various methods of transporting energy producing material from source to location of use, and the effects of that transporting on the environment.
   - Determine how many acres of land are required to accomodate a high voltage transmission line for 10 miles. List some uses of the land located under the transmission lines.

b. Describe 5 ways in which the automobile is helpful to man. Describe 5 ways in which the automobile harms the environment. Include, but do not limit your list to such facctors as sight, smell and hearing.

c. Tie white muslin collecting bags on the exhaust pipes of a small automobile, a large automobile, a bus, a diesel truck and a motorcycle for one minute each. Compare the findings.

d. For a 24-hour period, set squares of white paper (or glass slides coated with petroleum jelly) inside a house, inside and outside a school, near a manufacturing plant, and in the downtown area. Compare the findings.

3. Transportation accounts for 30 percent of the total energy consumed in Arkansas. Most of this is for personal use. Simulate the construction of a law which restricts the use of personal autos to reduce air pollution and space pollution. What will you say in the law? Send copies of the laws written by the class to state legislators.

3. Evaluation

Use Student Worksheets 30.13 - 30.14 as an evaluation.

4. Follow-Up Activities

Collect poems or songs that express environmental concerns; reproduce and bind these into small books entitled "Environment". Distribute these to other classes.

Divide into groups to write environmental poems, limericks, songs, skits, etc. Use these to put on a variety show for other classes and/or other schools.

Write and design environmental bumper stickers. Reproduce (preferably on recycle stock) and distribute as part of a community awareness campaign.

Organize a campaign of "communication through visual symbols" by collecting large posters on environmental protection, land use, conservation, etc. Display throughout the school.

TEACHER BACKGROUND INFORMATION

Source:

Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

The demands of environmentalists, which have gained increasing public support over the past decade, are now often viewed as making it more difficult to produce adequate energy for the nation. There is a widespread sense that energy self-sufficiency in the United States and pursuit of an all-out course to preserve and clean up our air and water are now in real conflict. It is not that Americans have turned their backs on the environmentalists. Instead, Americans are willing to bend a little on environmental priorities, and they feel that the environmentalists are not as willing to adapt to the new energy necessities.

The fact must be faced that for the foreseeable future clean energy is a mirage. All sources of energy cause one kind of environmental problem or another. Yet society need not be seduced into abandoning environmental protection goals for this reason. The time has come to weigh the unhappy choices available and chart the most direct possible course toward cleaner energy. In developing this strategy we must be certain that we control the most serious problems and not dissipate our resources by tackling all problems indiscriminately. Even though each energy source has its environmental costs, we can be selective in choosing areas and techniques to minimize adverse environmental impacts.

Fuel use harms the environment more than any other human activity: it heats the atmosphere, generates pollutants, scars the landscape, and creates dangerous radioactive by-products. We can justify some of these energy costs for necessary purposes. But to increasing numbers of people, the costs of continued energy growth now seem to outweigh perceptible benefits. The search for new energy systems involves more than just the need to provide an alternative to OPEC oil. The primary need is to find the kind of energy mix that will run an industrial society without imposing ghastly penalties on living things.

There is vigorous debate over whether the intermediate- and long-term energy strategy for Arkansas -- as well as the nation -- should follow a "hard path" or a "soft path". Following the hard path (or conventional route), major emphasis would be placed on coal and nuclear. The soft path would emphasize energy conservation and all forms of solar energy. There is a widespread belief that Arkansas' and the nation's choice is either the hard path or the soft path.

But the hard path and soft paths are not entirely mutually exclusive. Energy conservation is not an exclusive feature of the soft path. Energy conservation is compatible with both hard and soft technology, and the necessity for its implementation should transcend the hard versus soft debate.

Even though the soft path is the preferred path, because it is the less injurious to the environment, Arkansas should proceed with the development of all alternative energy resources, hard and soft, if such development is environmentally and socially responsible. We are presently not in a position to "close the door" on any energy option that represents a potentially significant contribution to our future energy supply -- unless the further development of that option is deemed environmentally and socially irresponsible by Arkansans.

Student Worksheet

ARKANSAS ENERGY AND ENVIRONMENT

1. Write some Arkansas industries requesting information on the various methods they use for pollution control. Compare the methods used, noting differences in methods for various industries.

2. Energy Transportation Systems Inc. (ETSI) was organized to develop a coal slurry delivery system for western coal. ETSI plans to transport 25 million tons of coal annually through a 1400-mile pipeline -- 255 miles in Arkansas -- from the Wyoming coal reserves to the Mid-South region. Write a movie script in which the main conflict is a struggle between those who favor construction of this pipeline and those who oppose it.

3. If Arkansas Nuclear One were to dispose of its waste heat in the Arkansas River, raising the average temperature of the river 5 degrees, what kinds of aquatic life would be affected and how? Construct a model of a modified food chain showing the interrelationships that would be altered.

4. Design a community-agricultural complex that would utilize waste heat from an Arkansas electrical or industrial complex.

5. List and describe three ways an Arkansas industrial plant could minimize or eliminate waste-heated water discharge to a river. Can you think of a way the industry could make use of this waste heat?

6. State the effect on the Arkansas environment for each of the following power plants:
   - -Coal-burning
   - -Oil-burning
   - -Natural gas-burning
   - -Hydroelectric
   - -Nuclear fission
   - -Geothermal
   - -Biomass (waste) conversion
   - -Solar electric

7. State the kind of fuel-fired electric plant you would prefer as a neighbor, and defend your choice. (Use Arkansas examples).

8. List five advantages and five disadvantages of locating a central electric power plant in a population area; in a rural area.

9. Discuss the problems that would occur if large scale mining of oil shale in the Ozarks began.

10. Outline the steps that would be necessary for land reclamation if the lignite in Arkansas were strip-mined.

Student Worksheet

ACID RAIN

Source:

Arkansas Gazette. October, 1980.

Those sweet spring showers and pure fluffy snowfalls turn out not to be so sweet and pure after all. In fact, some rain and snow are downright filthy.

High in the sky, before falling to earth, rain and snow often mix with pollutants -- mainly sulfur dioxide and nitrogen oxide -- and through a series of chemical changes become acidic.

By the time it reaches earth the stuff farmers and skiers are calling a godsend, scientists are calling "acid precipitation." Some rains and snow that have made their way to earth in recent years in this country have been almost as acidic as vinegar, and the acid precipitation problem seems to be spreading.

About 50 million metric tons of sulfur dioxide and nitrogen oxide are spewed into the air every year in the United States, as byproducts of fossil fuel combustion. Car engines, home furnaces, coal-burning power plants, and smelters all contribute.

As the use of coal increases, these pollutants could intensify, an idea that worries scientists because they really don't know how the pollutants travel, what happens after they come down, or exactly what kind or how much damage is being done.

Many do believe that acid precipitation can wipe the fish from lakes, corrode buildings and statues, leach minerals from soil, and possibly slow tree growth, damage crops, and taint drinking water.

Researchers already know that almost 200 lakes in New York's Adirondack Mountains that once drew fishermen are now fishless, apparently because of much greater than normal acidity. The dead lakes are at high elevations, where soil lacks buffering agents that neutralize acid as it pours into the streams.

The high acidity has already taken an economic toll. The Adirondack Park Agency estimates the decline of game fish has meant an annual loss of at least $1 million in recreational revenue.

Preliminary data show plant damage including reduced seed germination, problems with photosynthesis, lowered resistance to disease, and lesions on leaves. There is direct evidence that acid rain leaches minerals from soil and can even release soil's metals, sometimes sending them into streams or water supplies.

Some of the world's most majestic man-made structures -- the Parthenon, the Colosseum, Taj Mahal -- also are feeling acid rain's effects. The progressive disfiguring of the sculptures of the Acropolis, for example, has been the work of acid rain. It is even possible to see streaking on the Washington Monument -- possibly the result of acid rain's grooving, pitting effects.

Student Worksheet

ACID RAIN
(Continued)

In this country acid rain was first detected in the Northeast, but it appears to have spread south and west in the last 20 years despite the prevailing west-to-east winds. All states east of the Mississippi now are regularly stung by abnormally acidic rain or snow, and acid precipitation has found its way to urban areas of the West such as Los Angeles, San Francisco and Seattle. [In recent years the acid rains produced by the industrial areas in the Northeastern United States have regularly been reaching as far as eastern Arkansas.]

What perplexes scientists is how acid rain moves. Often shoved high into the atmosphere by tall smokestacks, the pollutants can be picked up and carried for weeks and miles before being dropped in rain or snow. The spring shower that drenches New England might be loaded with pollution from an Ohio valley power plant.

Some of our pollutants even wind up in storms over Canada, and the amount is expected to increase under a plan to convert dozens of American utilities to coal use.

In Scandinavia, where acid rain was first detected, the industrial areas of Britain and northern Europe are blamed. And some experts think an acidic haze over the Arctic was made in Japan.

Because its sources are so hard to pin down, acid precipitation passes over most of the country's clean air regulations.

One way to dry up acid rains sources is to cleanse coal of some of its chemicals before burning; another possible remedy for factories is the scrubber, which removes the byproducts of combustion before they are released into the atmosphere.

But some people are not convinced that acid precipitation is really hurting anything. A spokesman for the Electric Power Research Institute, an organization set up to do research for power companies, states, "We recognize the potential for harm, but we're not convinced that acid rain is actually doing damage in the real world."

Most scientists agree that the effects of acid precipitation are still in question, but they'd rather not wait around for a more precise picture to be drawn. As a plant physiolgist studying the phenomenon said: "By the time we determine the full effects of acid rain, it will be too late to reverse them.

Student Worksheet

ACID RAIN
(Continued)

Answer the following questions:

1. What area(s) of Arkansas are being affected by acid rain?

2. What are the main chemical pollutants in acid rain?

3. What is the source of these pollutants?

4. What are some effects that acid rain has on the environment?

5. How could the spread of the rain affect Arkansas' economy?

6. Acid rain in the United States first appeared in the ______________________, site of heavy ___________________ use; it appears to be moving in a __________________________ direction across the country.

7. How does acid rain often escape clean air regulations set by the United States Environmental Protection Agency?

8. What are some methods of preventing or reducing acid rain?

9. Atmospheric pollutants that contribute to acid precipitation are expected to increase as many United States utilities convert to ________________ as an energy source.

Student Worksheet

ACID RAIN
ANSWER SHEET

1. Eastern Arkansas

2. Sulfur dioxide
   Nitrogen oxide

3. Combustion of fossil fuels

4. Kills life in lakes
   Corrodes buildings and statues
   Leaches minerals from soil
   Slows tree growth
   Damages crops
   Taints drinking water

5. Loss of recreation revenue
   Crop loss

6. Northeast
   industrial
   southwesterly

7. Sources are difficult to pinpoint

8. Cleanse coal of some chemicals before burning
   Factory scrubbers to remove combustion by-products before they are released into the atmosphere
   Change in people's attitudes toward the effects of acid rain.

9. Coal

Student Worksheet

ENVIRONMENTAL IMPACT STATEMENT GUIDELINES

SUGGESTED GENERAL GUIDELINES FOR PREPARING AN ENVIRONMENTAL IMPACT STATEMENT

Adapted from Preparation of Environmental Impact Statements Guidelines, Revised Edition, April 1973. Environmental Protection Agency. See also Preparation of Environmental Impact Statements. Final Regualations. Published in the Federal Register, Monday, April 14, 1975, Volume 40, No. 72, Park II, pp. 16814-16827.

I. **DESCRIPTION**

A. Describe in qualitative and quantitative terms all biological resources and water resources. This discussion should include how the biotic communities have adapted to the physical environment, and should also include the hydrologic cycles of adjacent water bodies.
B. Describe the soil characteristics and geology in the project area.
C. Describe all natural resources in the project area, including wilderness areas. The statement should recognize that these wilderness areas are a diminishing resource.
D. Describe existing air quality and any applicable standards or regulations.
E. Include graphic and pictorial information.
F. Describe meteorological conditions in the area.
G. Describe past, present, and proposed land use.
H. Describe accessibility to planning area. Include transportation plans.
I. Describe the socio-economic situation in the community.

II. **ENVIRONMENTAL IMPACTS**

A. Discuss impacts which may occur to water quality, air quality, noise, solid waste disposal, and pesticide use.
B. Discuss the impacts the project will have on the physical environment such as soils, geologic formations, hydrology, drainage patterns, etc.
C. Discuss methodology to be used to minimize adverse environmental impacts. Where abatement measures can reduce adverse impacts to an acceptable level, the basis for considering these levels acceptable must be outlined.
D. Discuss the economic impacts of the proposed action.

III. **Alternatives**

A. Discuss the full range of management alternatives considered in the course of planning the action. The null alternative (the alternative of taking no ation) must also be evaluated.
B. Discuss why the proposed alternative was chosen.
C. Discuss alternatives in sufficient detail so others may realize secondary or long-term environmental impacts.

IV. **SHORT-TERM USE VS LONG-TERM PRODUCTIVITY**

A. Discuss environmental impact and economic costs and benefits as they relate to short-term uses and long-term productivity.
B. Discuss how actions taken now will (or will not) limit the number of choices left for future generations.

V. **IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES**

Discuss resources to be utilized and what the replacement potential of these resources is.

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Source: Project Learning Tree

Student Worksheet

PREPARING AN ENVIRONMENTAL IMPACT STATEMENT

In this activity, you will prepare an environmental impact statement (EIS) for a hypothetical site in your community, using the federal guidelines for EIS.

Here is the hyptothecial situation:

> An area in your community has been selected as the site for a 100-unit, two-story condominium housing development. The site has sewer and water lines within easy access. All existing trees on the land must be removed, but the developers agree to landscape the site when the building is completed. An excavation for the basement is also necessary.

Through class discussion, try to determine:

1. An appropriate location for the proposed condominium development.
2. Is a site study (EIS) necessary before development may be approved? If so, why?
3. What are the important environmental factors which should be measured before preparing an EIS? In other words, what data must be collected. How would these factors be measured?
4. What is meant by "short-term impact" and "long-term impact"? How long is "long"?

Divide into several consultant teams. Each team is to collect part of the necessary data as suggested in the EIS guidelines on Student Worksheet 30.11 and write a report.

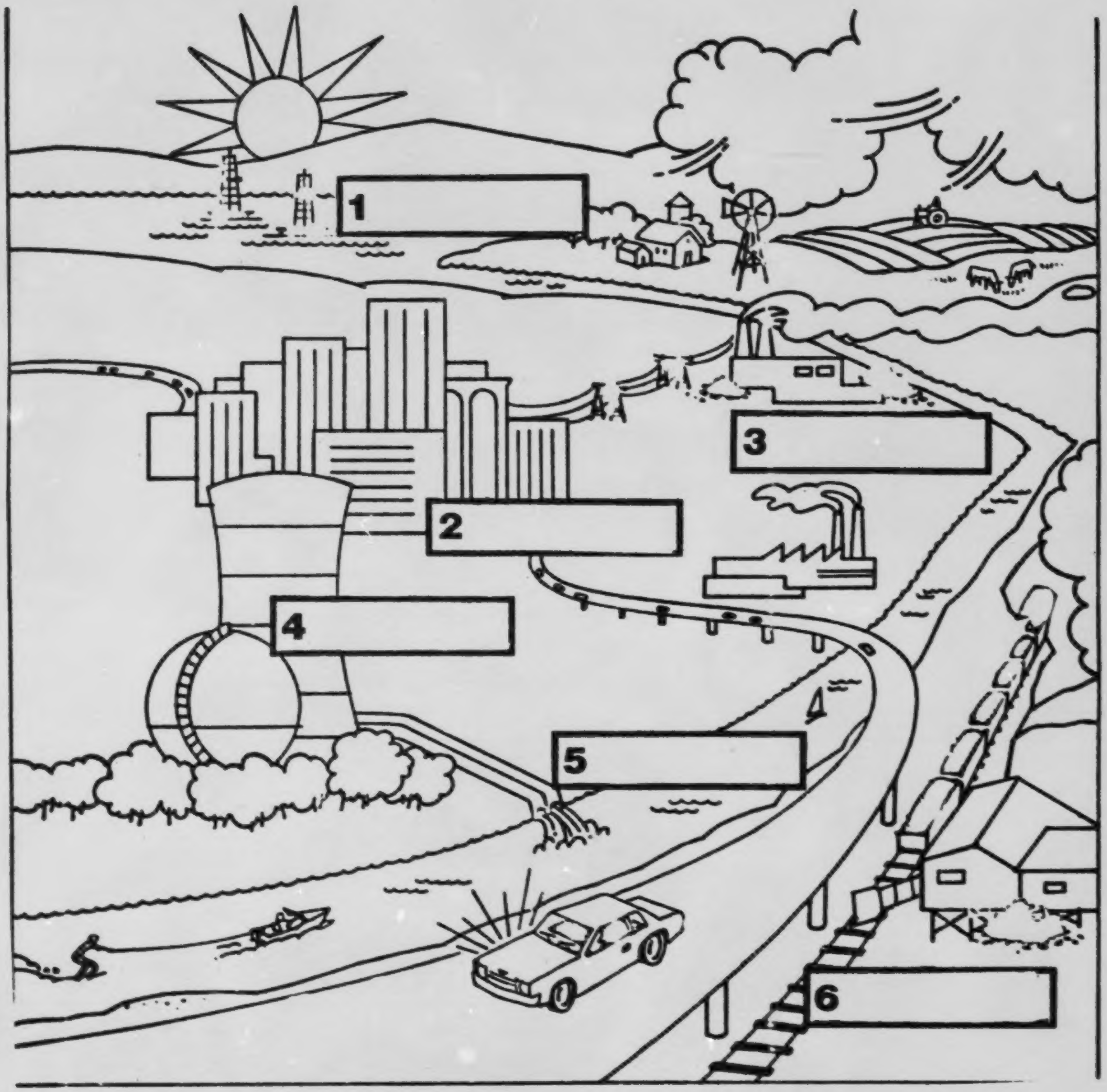
While doing the research, consider such factors as:

1. A description of the physical and biological resources of the site.
2. How the existing biotic (life-related) community has adapted to the physical environment.
3. Soil characteristics.
4. Air and water quality.
5. Climatic conditions including average rainfall, seasonal temperature extremes and averages, number of sunny days.
6. Accessibility of utility lines and transportation links to the site.
7. Unique or unusual characteristics of the site.

Source: Project Learning Tree

Student Worksheet

A DELICATE BALANCE



1. Name the possible sources for energy in the picture.
2. What energy sources shown are used to generate electricity?
3. Seven types of environmental pollution concern us today: air, water, thermal (heat), radioactivity, visual, noise, and land disruption. In the boxes on the picture above, write in the type of possible pollution occuring in that part of the picture.
4. How do different parts of your environment -- air, water, people, city, country -- affect each other?
5. To help keep that delicate balance between meeting our energy needs and maintaining a clean and healthy environment, what in your life would you be willing to change?

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Source: United States Department of Energy

Student Worksheet

A DELICATE BALANCE
ANSWER SHEET - 30.13

1. Sun, wind, coal, oil, nuclear
2. Coal, oil, nuclear
3. Box 1 - water
   Box 2 - air, visual, noise, land
   Box 3 - air, water, land, visual
   Box 4 - radioactivity, thermal, water
   Box 5 - water, air, noise
   Box 6 - air, water, visual, land, noise
4. Answers vary
5. Answers vary

ANSWER SHEET - 30.14

Air

Land
disruption

Water

Source:

Student Worksheet

A DELICATE BALANCE
(Continued)

1. "I know I will have to spend more dollars to pay for electricity, fuel, gasoline, and other energy-related products so that energy producers can pay for environmental controls."
2. "I will cut back on my own energy use -- really practice conservation."
3. "I will support more government regulations."
4. "I can count on business and industry to find the answers."
5. "I'm willing to live with pollution."

From the clues given on the chart below, identify each type of pollution: water, air, or land disruption. In the last column of the chart, place the number of the choice listed here that you agree with.

TYPE OF POLLUTION	WHAT IS IT?	WHAT CAN I DO?	HOW CAN IT BE IMPROVED?	WHAT WOULD I BE WILLING TO DO?
	It is the adverse effect from burning coal and oil, and from car exhausts. It is high concentrations of carbon monoxide, sulfur dioxide, and unburned ash.	It can increase respiratory illnesses and raise death rates. It can damage crops, plants, and trees.	By installing emission controls on autos and filters or traps on chimneys. By cutting down on the burning of coal and oil. By burning solid wastes in closed incinerators. By capturing and reusing industrial gases for other products.	
	It is the use of millions of acres for mining, development of power plants, refineries, transmission lines, energy-resource storage, and solid waste disposal.	It can disturb wilderness and recreation areas. It can destroy vital plant-animal food chains and can cause erosion and loss of soil nutrients.	By reclaiming mine sites. By landfilling and recycling solid wastes. By replanting vegetation, reforesting, building lakes and recreational parks.	
	It is high amounts of impurities such as disease-causing organic wastes, toxic substances such as acids and pesticides. It can be caused by oil spillage, offshore construction, industrial waste, and municipal sewage.	It can disturb or destroy fish breeding and feeding grounds, can cause taste and odor problems, clog streams, destroy recreation areas and sometime cause disease in humans. Mines can contaminate ground water.	By installing filters, aeration and settling devices. By breaking down impurities with chemicals. By cleaning up rivers and shorelines. By transforming acid wastes to useful by-products.	

THINK ABOUT IT: Make a list of things you can do today to help stop pollution. Start with these: Don't litter. Recycle. Use public transportation. Don't burn rubbish or leaves. Can you add to the list?

LESSON #31

CATEGORY: Impacts

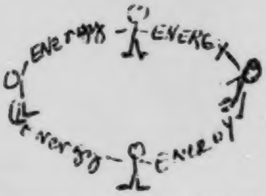
TITLE: We're All in This Together

INFUSE WITH SUBJECT AREA:
Social Studies

ENERGY TYPE: All

GRADE LEVEL: 10-12

TIME NEEDED: Two periods



MATERIALS:
None

OBJECTIVES:

1. The students will become aware that there are many opinions that must be taken into consideration in the study of any one energy problem.
2. The students will investigate some of their own beliefs about energy and come to realize that:
   No one is energy independent.
   Each individual has a responsibility to conserve energy.

TASK ANALYSIS:

The students should be able to consider facts, then make decisions concerning these facts.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 31.6 - 31.7.

2. Steps in Lesson
   Objective #1 The students will become aware that there are many opinions that must be taken into consideration in the study of any one energy problem.
   a. Have students begin a file of magazine and newspaper articles related to energy problems in Arkansas. Special attention should be given to articles providing suggestions for increasing the availability of energy such as:
      -Strip mining Arkansas lignite.
      -Constructing plants that operate on trash power.
      -Transporting energy by such means as a Wyoming-Arkansas coal slurry pipeline.
      -Increased nuclear-fission power in Arkansas.
      -Mining of Ozarks oil shale.
      -Development of Arkansas geothermal hot spots in the Ouachita Mountains.
      -Encouragement of more efficient use of energy by all consumers.
      -Using solar energy for heating homes and water.
      -Development of alcohol (gasohol) productions plants.
      -Increasing efficiency and use of wood-burning stoves.
      Assign a panel of students to weigh the pros and cons of each of the possibilities suggested by the articles. This panel could hear the arguments of 3 students selected to play the roles of, respec-

tively, an energy company executive, an environmentalist, and an official of the Arkansas Energy Office. After the arguments have been heard and the panel has deliberated, conduct a secret ballot of class members to determine the practicality of each suggestion.

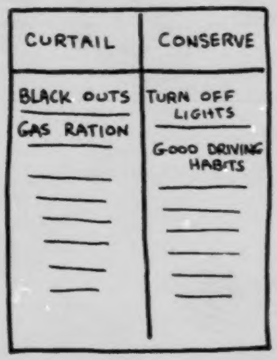
b. Conduct a debate, dividing the class into the following groups (or any others suggested by the class):

Manufacturers
Conservationists
Planners
Oil companies
Coal mine owners
Foresters
Teachers
Workers
Judges
Young citizens

Each group should proceed to assert its right to control the production and use of the energy resources of Arkansas and must defend its position. Set a time limit on each group's presentation. After the deliberations are completed, have the judges report to the class on which group they feel did the best job of presenting arguments for their point of view.

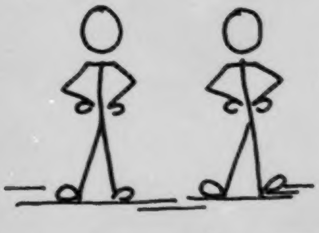
c. Put the following two headings on the chalkboard:

Energy curtailment
Energy conservation



Ask the students for a definition of the two words. If you wish, share the following statement with the class: Energy curtailment is forced energy saving. Curtailment can result either from events dictating decreased energy use, such as when supplies are suddenly interrputed and factories are forced to close, or from government mandates requiring drastic changes in the way we live, work, and play, such as outlawing automobiles.

Energy conservation is adjusted energy use, entailing such actions as insulating houses, trading in 15-miles-per-gallon cars for 40-miles-per-gallon cars, and capturing and using the waste heat of industrial processes.



Have the students list as many items as possible that can be placed under each heading. Write them on the chalkboard, no matter how unlikely they may sound.

Ask:

-Which list would you prefer to live with? Why?
-Explain the difference in altered life-style and reduced life-style.
-Why do some people equate conservation with "doing without"?
-Can conservation be practiced without reduction in life-style? How?

Objective #2: The students will investigate some of their own beliefs about energy and come to realize that:
No one is energy independent.
Each individual has a responsibility to conserve energy.

a. Hand out Student Worksheet 31.6. Have the students do the activity as individuals. Discuss any changes in beliefs the students might have.

b. Ask students to pick out a favorite item in their life which is a forest product; for example, surfboard, skateboard, wall-poster, kite, clogs, book.
Invite the students to trace their fvorite item back to its origins. Encourage them to find out whether their items are entirely forest products. Ask the students to include any resources which were used in the manufacture of each item, and any which contributed in bringing the items to the students. Then ask the students to make pictures representing all the material and energy inputs in the entire journey of their items from the forest to their present locations. (One could create a wall mural starting with photosynthesis.)

Ask each of the students to count the number of times there was a conversion (transfer) of energy in the total production and transportation of the favorite item. Ask each to write an equation to represent all the resource inputs on one side, with the pleasure of the student in having or using the item on the other. Are they equal?
Are there other factors to account for?

Suggest that each student look again at the picture of all the resources involved in the production of the favorite item. What else could have been made from the same materials which made the favorite item?
Ask the students to continue the pictures to represent where their favorite items will go when they are through with them; for example, through reuse on to eventual decay. The students can determine the life expectancy of their items, determining how long it will take their items to be converted through decay into soil.

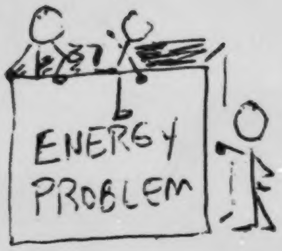
c. Hand out Student Worksheet 31.7. Divide the class into small groups and have them do the activity. Discuss the results as a group.

d. Ask: "Are you part of the energy problem?"
Ask the students who feel that they are not part of the energy problem to defend their position. Have a recorder keep a record of the discussion.

Ask: "What have you done today to conserve our scarce energy supplies?
Make a list of things students did to conserve energy during the past week.

Ask the students to record for one week:
-Number of times they opened the refrigerator

-Ask their parents to drive them somewhere
-Rode a bicycle instead of asking for a ride in the car
-Drank a cold drink
-Used ice cubes
-Took a hot shower
-Sat in an over-cooled room
-Watched television
-(Have students add other items)



Ask again: "Are you part of the energy problem?"

e. Divide the class into groups. Have each group represent a family unit. Let the groups have different numbers of students to represent different family situations. Have students assume roles in the family units (father, mother, children, grandparents, etc.).
Present one of the following situations to the students:
(Do not let any group know the situation of any other).
-Because of a critical shortage of natural gas and fuel oil, each family is asked to cut back on its fuel consumption for heating by 20 percent. What things can each family member do to meet this goal?
-Because of an ice storm, flood, or tornado (a major disaster), the sources of electricity and water for the community have been damaged. How can the family adjust and function in this situation? How can it perform activities that usually require power?
-Gasoline has been rationed to 8 gallons per week per family. Decide what kind of car the family has and determine how many miles it can travel on that amount of gasoline. What travel is necessary for the family?
How can the family help to make the 8 gallons meet its needs?
-This emergency meeting of the chamber of commerce has been called because:
*Due to a critical shortage of natural gas and fuel oil each family has been asked to cut fuel use by 20 percent.
*A major disaster has damaged electricity and water supplies.
*Gasoline has been rationed to 8 gallons per week per family.
You are to discuss what will happen to the supply and price of such items as insulation, caulking, storm windows, small cars, gasoline, etc. How can you business leaders meet the demands of the people fairly?
What will your reaction be?
Have each unit report to the rest of the class on how they solved the situation. Make a list of suggested solutions.

3. Evaluation

Check Student Worksheet 31.6 for changes in student knowledge and beliefs.

4. Follow-Up Activities

Have the students write and illustrate short stories or poems describing what they think their life might be like in the year 2000, with emphasis on the use of energy. Have them compute how old they will be then, and what their job and home might be like.

Have students design a bulletin board considering the energy dilemma and such factors as:

Environmental impacts
Transportation
Industrial pollution
Uses
Ecosystems
Trade-offs
Industrial sites
Sources
Limits
Future

Conduct "college bowl" or "bee" types of quizzes involving the whole class and centered on energy.

Student Worksheet

ENERGY BELIEFS

List all the things you have heard or read about the energy situation under the appropriate heading. Once listed, research each statement to gather data supporting your "belief". Record any changes of your beliefs.

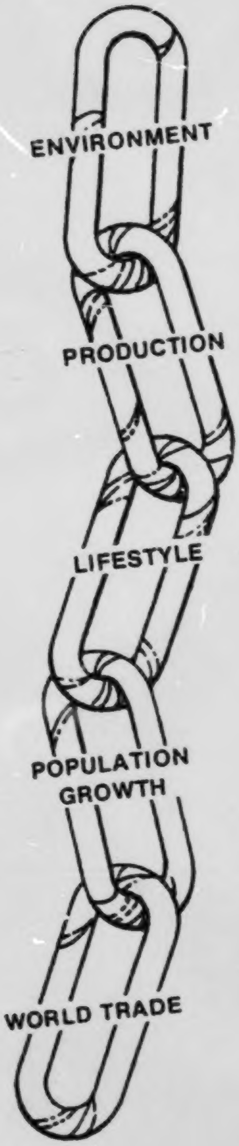
WHAT I BELIEVE	WHAT I DO NOT BELIEVE
Example: Energy costs more than it used to, and will keep rising.	Example: Energy companies are doing everything possible to keep consumer costs down.

Student Worksheet

THE ENERGY CHAIN

Population growth, production of goods and services, dependency on foreign oil supplies, environmental health and safety, and the effect of these on our lifestyles -- each of these is a link in the chain of energy use. Each is a part of the energy challenge.

Draw a line from each short story to the appropriate link. Form small discussion groups. With others in your group, define the problem in the following situtions and discuss what your solutions might be.



1. Time: One possible day in the future. Canada has decided to stop exporting oil. Some of the other oil-producing countries decide to band together and withhold oil in order to raise prices. U.S. supplies of oil are suddenly cut in half. There is no milk or bread in your house, no gas in the car, and you live 5 miles from the nearest store. What kinds of problems would you and your community face if there were a serious oil- shortage? How could you solve these problems?

2. Each year the number of students in your classroom increases. This means more seats in less space, more noise, less personal help from your teacher. A new business has opened in your town, employing 300 people. Suddenly, your class size has doubled. How will this affect you and your school?

3. A large utility company is planning to build an electric generating plant right where you and your family camp and fish every summer. The coal resources are nearby (mining hasn't started yet, though) and the city 500 miles away is desperately short of electric power. Should the plant be built? Why or why not?

4. Your uncle manages a large farm that produces many food products. He operates tractors and giant combines; he runs a gasoline powered irrigation system, cow-milking machines and crop-drying equipment. He uses fertilizers made from petroleum. Because petroleum is scarce, his costs have more than doubled. If he cuts back on his use of petroleum-based products, he would seriously reduce food production per acre. Is there any way he can cut back on his reliance on petroleum? How can consumers help cut energy needs for food production?

5. The annual operating budget of your city (your public tax money) can pay for either completion of the super highway system or enlarging the suburb-to-city mass transportation system, but not both. Most commuters don't like to ride buses, so the buses are usually only half full. The vote is coming up at the council meeting next week. How should the council vote?

Source: United States Department of Energy

Student Worksheet

THE ENERGY CHAIN
ANSWER SHEET

1. World trade
2. Population growth
3. Environment
4. Production
5. Lifestyle

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LESSON #32

CATEGORY: Impacts

TITLE: Yesterday, Today and Tomorrow

INFUSE WITH SUBJECT AREA:
Social Studies
English
Art

ENERGY TYPE: Direct Solar

GRADE LEVEL: 7-10

TIME NEEDED: One period

"GOOD MORNING"

MATERIALS:
Reference materials on solar history

OBJECTIVES:

1. The students will discover the relationship between people and the sun throughout the ages.
2. The students will investigate their own feelings toward the sun.

TASK ANALYSIS:

The students should be able to do independent research.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheet 32.4
   Gather above-listed materials.

2. Steps in Lesson
   Objective #1: The students will discover the relationship between people and the sun throughout the ages.

   a. Read to the class the song to the sun written by Saint Francis of Assisi in 1224:
      Praise to you, my Master, for all your creatures,
      Foremost for lordly Brother Sun
      Who lights our daytime for us.
      He is a beautiful thing who spreads forth a great splendor,
      Of you Most High, he is the visible emblem.

      Read the following pasage from the Papago Indian ceremony to the sun:
      In the east is the house of the sun.
      Up over the top of his roof-beam
      The sun climbs and journeys
      Over the heads of us
      Who make our journey below him.
      I stretch my right hand sunward,
      Then trace upon my body
      The ritual sign.
      (This ritual, called a "ciwiltkona" is performed by dancers who believe that they recharge themselves with the sun's energy as they circle a sand painting of the sun.)

      Using Student Worksheet 32.4, discuss symbolism and inspiration found in the sun through history.

b. Ask the students to express the feelings these passages bring to their mind. Ask why they think people through the ages have felt such strong emotions when they contemplated the wonders of the sun.

c. Divide the class into small groups. Assign each group one of the following topics to research and report on:
  - Henry Thoreau's comparison of daybreak and the rising of the sun with spiritual awakening.
  Find two or more authors who have written about sun power and compare their descriptions of the sun.
  - Investigate Inca worship of the sun. Find pictures of the Inca temples to the sun "Father".
  - Find "Sun Fathers" in other cultures.
  - Investigate the culture of one of several groups of Arkansas Indians (Caddo, Bluff Dwellers, Osage, Mound Builders, etc.) and their relation to the sun; the uses they made of it.

d. Either reassign the groups or assign the following new topics to the same groups. Have them research and report to the class on these subjects:
  - Investigate the solar architecture of the Pueblo Indians (design for heating, cooling, ventilation, illumination, and integration with natural cycles of season and climate). Ask: "How does this solar architecture correspond to animal structures -- beehives, ant hills, animal burrows, bird's nests, etc.?"
  - Investigate the suggestions for siting and orientation of houses, buildings, and even cities with regard to the sun, prevailing winds, and other climatic and geographic features by the ancient Roman architect Vitruvious in the time of the Emperor Augustus.
  - Ask "Why were early American barns painted red?"
  ("Paint" was skim milk mixed with iron rust coloring and lime, which absorbed sunlight - a "solar heating device").
  - Predict the future for buildings like the World Trade Center twin towers, with over 100 stories, and no insulation or windows that will open. Discuss how a building like this could have been designed and constructed. (Energy was so cheap; there was no reason to be concerned about the costs of heating, cooling, or lighting).
  - Investigate modern solar architecture in the United States to determine how it is like -- or unlike -- ancient solar architecture. Ask: "Why has modern man lost the art of solar architecture in the high energy society? (Air conditioning has replaced mental skills and ingenuity in dealing with nature).

Objective #2: The students will investigate their own feelings toward the sun.

a. Have the students do their choice of the following:
  - Write a myth about the sun.
  - Describe the warm red pulse of the sun; its light reaching into you; your feelings as you watch its wonders of shore and sky.
  - Draw a picture of yourself enjoying the sun. Describe your picture.
  - Set the words of the "sun songs" to music.
  - Write a poem which expresses your feeling about the sun.
  - Write a new verse to the John Denver song "Sunshine"; The Beatles song "Here Comes the Sun"; "Let the Sun Shine In" from the musical Hair; "You Are My Sunshine."

3. Evaluation

Ask the students to write a short paper completing the following phrases:
"The sun is -- "
"The sun was -- "

4. Follow-Up Activities

Ask the students to complete the following phrase: "Solar radiation is -----". (Consider its nature, appearance, effects, capture by plants, use by animals and man).

Discuss the student responses and make a list of possible topics for further discussion and investigation.

Investigate the device known as the "Camera Obscura", the dark room prototype of the camera.

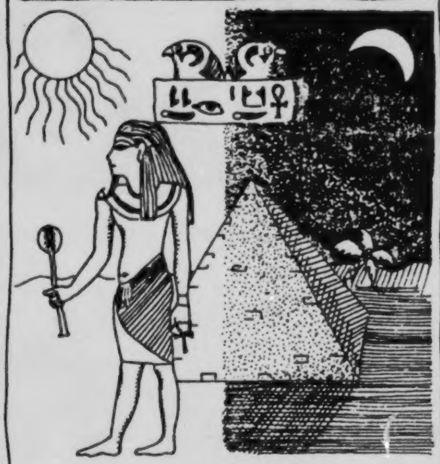
Make "sun pictures". Place sheets of blue-print paper in the sun with you hand, a piece of lace, a leaf, etc. on it for a few minutes, until it turns blue. The object will leave a white print.

Make sun cut-outs from construction paper with colored cellophane insert to hang in class room windows or to make mobiles.

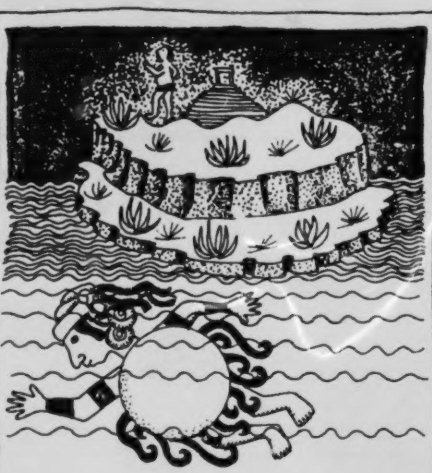
Make a class sun-dial, decorate it with ancient symbols and designs.

Student Worksheet

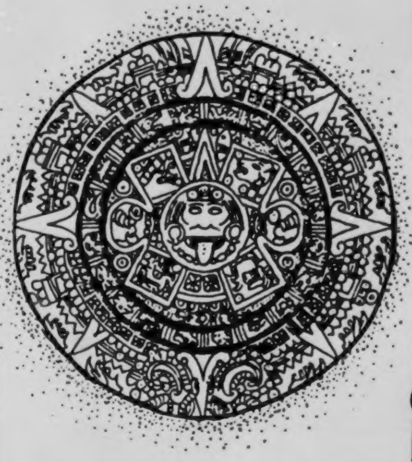
SOURCE OF SYMBOLISM AND INSPIRATION



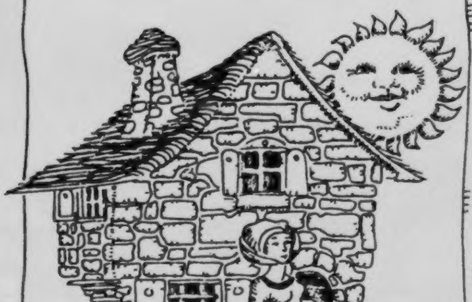
The sun has been an inspiration to people. Egyptians believed the sky was a falcon. One eye was the sun; the other was the moon.



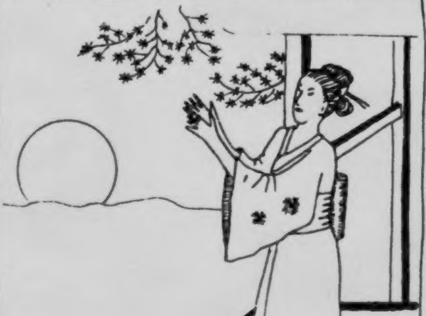
The Inca Indians of ancient Peru worshipped the sun. When the sun went down at night it swam under the earth until morning when it rose again.



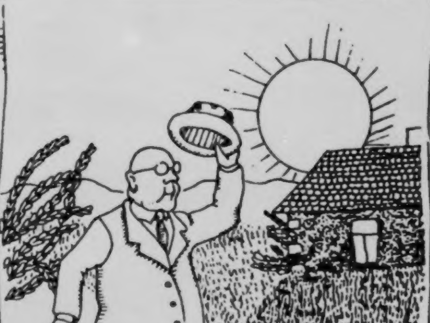
The Aztec Indians of ancient Mexico also believed the sun was a powerful god. They built their calendar around it.



Artists in northern Europe in the 15th and 16th centuries pictured the sun as a happy, caring face.



In Japan, some people welcome the sun each morning by clapping their hands.



And in some towns in Europe, men still follow an age-old custom. They tip their hats to the rising sun.

Source: National Center for Appropriate Technology

LESSON #33

CATEGORY: Sources

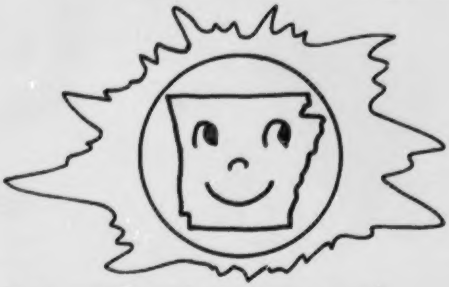
ENERGY TYPE: Direct Solar

TITLE: Here Comes the Sun

GRADE LEVEL: 9-12

INFUSE WITH SUBJECT AREA:
Science

TIME NEEDED: Two periods



MATERIALS:

2 foam cups
2 thermometers
Food coloring
Aluminum foil
Graduated cylinder
Metric ruler
Watch
Insulation material (packing foam or crumpled newspaper)
Cardboard box

OBJECTIVES:

1. The students will recognize our dependence on the sun as an energy source.
2. The students will calculate the amount of solar heat that actually reaches earth.
3. The students will consider an overview of solar energy facts.

TASK ANALYSIS:

The students should be able to read material and answer questions on material; do basic math computations; and follow directions to do experiments.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 33.6 - 33.14.
   Read Teacher Background Information (33.3 - 33.5).
   Gather above-listed materials.

2. Steps in Lesson
   Objective #1: The students will recognize our dependence on the sun as an energy source.

   a. If you wish, share the information on Teacher Background Information (33.3 - 33.5) with the students.
   b. Hand out Student Worksheet 33.6. Have the students read the material, then answer the questions. Discuss the answers in class.
   c. (Optional). Hand out Student Worksheet 33.7. Have the students do the activity individually, then compare answers.

   Objective #2: The students will calculate the amount of solar heat that actually reaches earth.

a. Hand out Student Worksheet 33.8. Have the students read the information, then discuss in class.
b. Hand out Student Worksheet 33.9. This activity may be done as a teacher demonstration or as student experiments. Discuss the results in class.

Objective #3: The students will consider an overview of solar energy facts.

a. Hand out Student Worksheets 33.10 - 33.14. Have the students read and discuss the material given. Have the students answer the questions individually, then discuss as a group.

3. Evaluation

Have the students research answers to the following questions:
-What kind of heating system does your house have? (Hint: What is the heat source, heat distribution system and heat control system in your home?)
-How much do you think it costs to heat your house for one month in the winter? (Check with your parents).
-What climates would be better for solar heating?
-Would your home be able to use solar heat? (Hints: Is the south side unshaded? Is your home well insulated?)
-Are there places in your community where you can buy solar collectors? (Check the telephone book.)

4. Follow-Up Activities

Have the students do research on the movement of heat. Divide the class into three groups:
Group one - conduction of heat.
Group two - radiation of heat.
Group three - convection of heat.
Have the students look up the definition of their group name; then devise a brief demonstration that will illustrate this method of heat transfer to the class.
For example:
Heat always moves from a hot object to a colder one. When two objects are touching each other, heat is transferred by conduction. When you lean against a cold wall, you warm the wall by conduction. When you lean against a warm wall, the wall heats you.
When two objects are not touching each other, heat still travels from the warmer to the cooler one, but this type of heat transfer is called radiation. The sun heats the earth by radiation.
When heat is carried from one body to another in a medium such as air or water, and the transfer depends on the fact that warm media rise while cold media sink, this process is called convection.
Air near the top of a room will be warmer than air near the floor because of convection. You can often feel cold air flowing into a warm room through the space underneath a door. In summer, you open the top half of your windows to let out the warmer air near the ceiling.

TEACHER BACKGROUND INFORMATION

Sources:

Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

United States Department of Energy. Solar Energy. United States Department of Energy: Washington, D.C. 1979.

The earth has always depended on the sun directly and indirectly for energy. Its rays provide the heat and light that enables earth's life-forms to survive. With the discovery of fire, wood (a form of indirect solar energy) became the first source of controllable energy, and even today one-third of the world's population depends on firewood as its principal fuel source.

A combination of heat from the sun and pressure from earth's layers chemically changed the remains of plants and animals into the fossil fuels - coal, oil and natural gas.

The sun continuously evaporates some of the earth's waters, which return as rain to feed streams and rivers. Water mills powered man's early industry, and modern hydroelectric plants are an important source of power.

The unequal amounts of solar heat falling on different parts of the earth's surface generate winds, which moved sailing ships and powered windmills.

Each day the sun delivers an average of about 1500 BTS's per square foot throughout the United States. Geographical location, cloud cover, and seasonal changes vary the amount of useful radiation reaching the earth's surface. Each square foot of the Southwest daily receives some 2200 BTU's of usable solar energy in the summer, and the Northeast receives as little as 1200 BTU's per day in the winter. Consequently, precise information on the amount of solar energy available at a proposed site is necessary for efficient and practical system design.

It is estimated that only half the solar energy entering the earth's atmosphere reaches the surface; every square yard of the surface we live on receives 1000 watts of heat each day.

Compared with other ways of producing energy, solar energy has many advantages. It is inexhaustible, intermittently available everywhere, requires no fuel and thus cannot be rationed by other nations, and minimal damage is done to the environment. Solar energy, however, also has some disadvantages. It is spread diffusely over the earth; hence, though solar energy is in a sense "free", it must be collected. Secondly, it is intermittent and therefore requires some means of storing energy when there is no sunshine. This "on-again, off-again" feature of solar energy is the greatest barrier to its wide-spread use.

These factors have put solar energy at a disadvantage, but with the cost of conventional fuel continuously rising, solar is becoming increasingly competitive; especially when the life-cycle cost is considered.

Arkansas, a "sun belt" state lagged behind most other states in solar development. But with the twin spectres of fossil fuel scarcity and spiraling prices, the sun has become a more serious candidate for an alternative energy source, for Arkansas as well as the nation.

Thus, solar energy will play an increasingly important role in our energy use patterns as we search for an economically and environmentally acceptable solution to our dilemma.

Solar energy takes many forms. It can be tapped through innovative architectural design, it can be gathered by collectors for heating and cooling, it can be concentrated for intermediate and high-temperature applications, it can be converted directly into electricity, and it can be utilized indirectly in the forms of wind, falling water, and biomass (organic materials) conversion.

"Solar energy" is a collective term that includes many different energy sources. The United States Department of Energy has classified solar energy into a number of individual categories which can be organized into three major groups:

1. Thermal applications (heating and cooling).
2. Biomass conversion (including wood, biofuels and wastes).
3. Solar electric (including hydropower, wind, solar cells and solar thermal electric).

There are a number of solar energy conversion systems that offer promise for the future. Some of these systems are:

1. Direct solar heating and cooling of buildings. The technology includes space heating, space cooling and solar water heating. Using this method each building would have its own collection system, independent of a municipal system. Though expensive to install, these systems have an almost negligible maintenance and operating cost; which means they are economic over the life-cycle of the installation.

Solar radiation passes through the layers of glass on the collector, and heats the black (heat absorbing) metal plate in which the pipes are embedded. The transfer fluid that flows through these pipes is heated, then collected in a large tank. In some systems, this fluid would then be circulated through the house in conventional hot water systems. In others, the fluid would be used to heat air, which would be blown through ducts as in forced-air systems.

The best use of solar energy is in use of building design that takes advantage of the sun's properties. When incorporated into new construction this method is economically competitive. Retrofitting existing homes for solar is more expensive and less efficient, but is being done successfully.

2. Photovoltaic electric power system, or solar cell. When solar radiation strikes the silicon chips in a solar cell, an electric current is produced. The process requires no equipment that will wear out, is environmentally safer than conventional energy sources and has a long life expectancy. The immediate obstacle to the widespread use of solar cells as an energy source is two-fold. First of all, the energy-conversion efficiency of the cell is low -- less than 20 percent; however, conversion to electricity by any means in highly inefficient. For example -- coal to electricity yields about 10 percent efficiency. Secondly the economic cost of necessary technological development to mass produce the cells is high; but this cost is expected to drop as use increases.

3. Solar thermal conversion. This system consists of solar collectors and thermal storage devices delivering high-temperature thermal energy to a turbine power plant. One possible method of utilizing this would be a solar "farm" made up of many collectors with curved surfaces that concentrate and focus the sun's rays at one point, creating very high temperatures. This point may be a pipe containing water or some other liquid which the intense heat will turn to a gas, which can then be used to power a turbine.

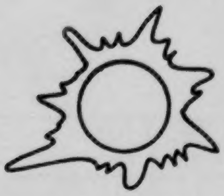
4. Wind-energy conversion. Wind energy is a secondary form of solar energy derived from heating of the earth by the sun that can be converted by wind turbines to mechanical energy and to electricity. Northern Arkansas is considered to have "fair" wind potential; while southern Arkansas is labelled "low". Despite its environmental attractiveness as a minimally-polluting energy source, wind power probably will not be able to provide a large part of the total Arkansas energy requirements because of its variability. However, wind power could make a valuable site specific energy source.

5. Bioconversion to fuels. The bioconversion to fuels (BCF) involves the use of the sun to grow plants which may then be converted to clean, burnable fuels. Biomass (organic materials) can be most readily converted to energy by burning, or direct combustion. Other techniques produce fuels from biomass (called biofuels). These include: Gasification and liquefaction to make natural gas-like and petroleum-like products; anaerobic digestion or treating biomass by certain bacteria to produce a synthetic gas; and fermentation to produce gasoline substitutes.

Biomass energy is renewable, causes less pollution than burning of coal and oil, and does not have the storage problem of direct solar energy. The limiting factor of biomass energy may be its low net useful energy yield. To provide moderate net useful energy yield the biomass must be collected and burned directly near its source.

6. Ocean thermal conversion. Power plants would take solar-heated water from the upper level of the ocean and use this heat to turn a liquid with a low boiling point to a gas to drive a turbine. Then, cold water would be brought up from a lower ocean level via a pipe to condense the gas, and the process would be repeated. This process is speculative at the present time, but offers future promise as an energy source.

The unifying concept of "solar" is that it is energy that arrived on the earth from the sun "recently" (during the last hundred years or so). The fossil fuels are also part of the earth's solar energy system, but have been around longer (millions of years). Indeed, all energy on the earth, directly or indirectly, has come from the sun.



Student Worksheet

LET'S POWER EARTH WITH THE SUN

The sun, 93 million miles away from earth, sends more radiant energy toward the earth every second than we will ever need or use. Thirty (30) percent of this energy is reflected back into space by earth's atmosphere. Much of the remaining energy heats the land, evaporates water and melts the ice and snow. It is the energy source that creates the winds, ocean currents and warms the atmosphere around us.

Energy from the sun interacts with oxygen at the top of the earth's atmosphere to create a layer of ozone that protects us from lethal amounts of the sun's ultraviolet radiation. Solar energy reacts with plants in the chemical process of photosynthesis to provide the stored energy that fuels life. Coal, oil and natural gas, once swamps of the ancient earth, are stored solar energy. All of these are ways we benefit from the sun's energy directly.

We also benefit indirectly by using "secondhand" energy from the sun. The electricity generated by a windmill, for example, is the sun's energy once removed. So, too, is the energy our bodies get from the food we eat, or the heat from wood we burn. Humans from the dawn of history have put the energy from the sun to work to keep warm, grow food or by harnessing the wind or the rivers.

Less than one percent of the incoming solar energy is used to sustain plant and animal life, yet this amount is many times greater than the total electric generating capacity of the entire world. The sun could be an important answer to our energy dilemma. All we have to do is find the "key to the bank."

Put a D beside each of the following things that result from energy received directly from the sun. Put an I beside each thing that results indirectly from the sun's energy.

___Coal deposit

___Sailboat

___Salt flat

___Gasoline

___Steam engine

___Photosynthesis

___Ozarks stream

___Arkansas River dam

___Rice field

___Ozone layer of the atmosphere

___Candy bar

___Electric heater

___Leaves turning green

___Ocean current

Answer the following questions:

1. In what ways did early people use the sun to do work for them?
2. What has the energy from the sun made possible in your life today?
3. Why is the sun called the source of all energy (except nuclear)?
4. Imagine life on earth in the future if we learn to harness the power of the sun to provide heat, light and electricity. What problems would be solved? What problems might be created?

Source: United States Department of Energy

Student Worksheet

LET'S POWER EARTH WITH THE SUN
ANSWER SHEET

D Coal deposit

I Sailboat

D Salt flat

I Gasoline

I Steam engine

D Photosynthesis

D Ozarks stream

I Arkansas River dam

D Rice field

D Ozone layer of the atmosphere

I Candy bar

I Electric heater

D Leaves turning green

D Ocean current

1. To keep warm, grow food, harnessing wind or rivers
2. Answers vary
3. Fossil fuels, wind, water, wood are all forms of solar energy, whether direct or indirect. Nuclear energy is the result of radioactive elements in earth's crust.
4. Answers vary

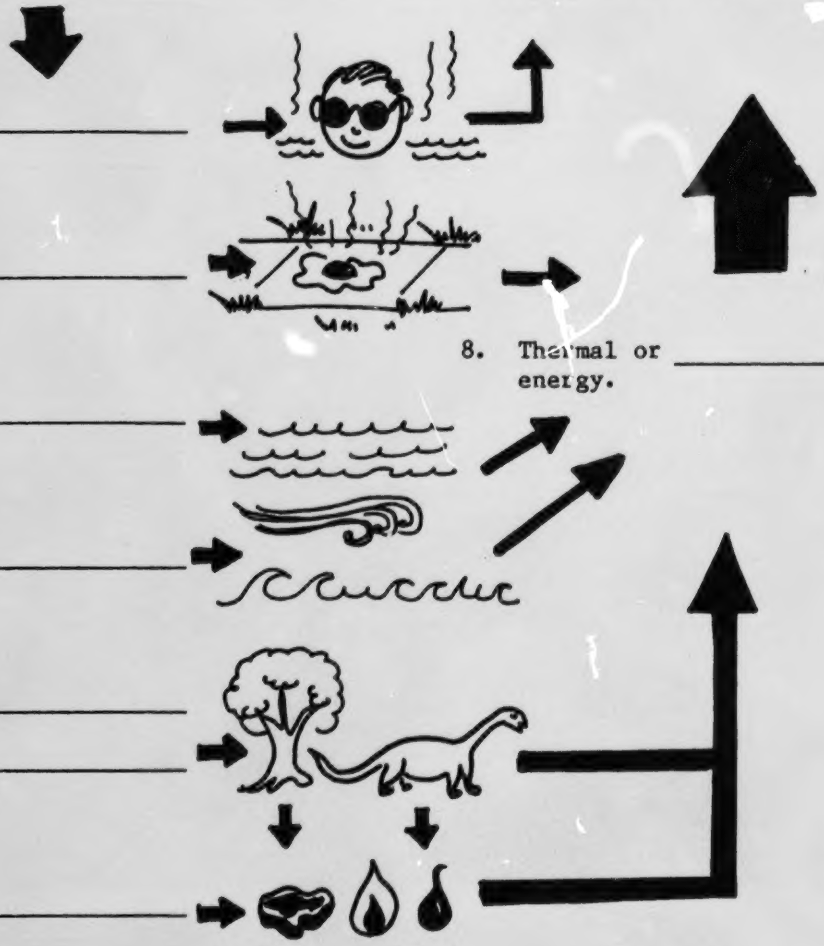
Student Worksheet

SOLAR ENERGY FLOW THROUGH THE PLANET EARTH

What are some of the things the sun does for earth and its inhabitants? Fill in the blanks below to label each solar service the earth receives. Can you think of other solar applications to add to the flow chart?

1. Energy arriving on _______ from the sun in the form of __________.

9. Energy leaving ________ and going off into __________.



2. ______________________________

3. ______________________________

8. Thermal or ______________ energy.

4. ______________________________

5. ______________________________

6. ______________________________
____

7. ______________________________

Source: United States Department of Energy

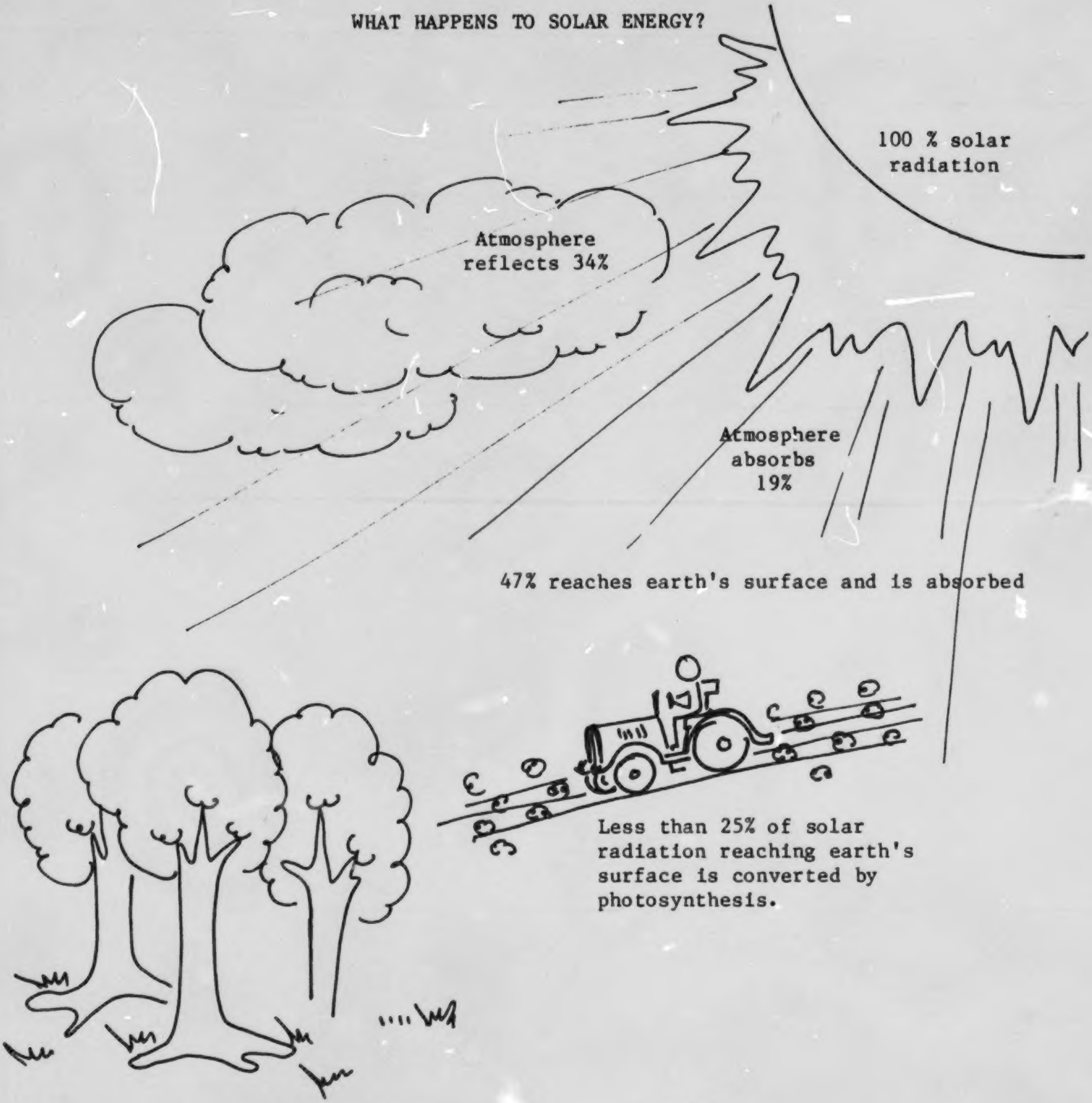
Student Worksheet

SOLAR ENERGY FLOW THROUGH THE PLANET EARTH
ANSWER SHEET

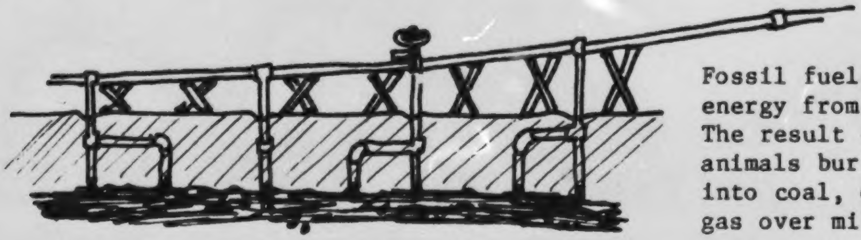
1. Earth, electromagnetic radiation.
2. Reflected sunlight.
3. Direct conversion to thermal energy (heat).
4. Evaporation of water.
5. Winds and ocean currents.
6. Photosynthesis.
   Plants and animals.
7. Fossil fuels.
8. Heat.
9. Earth, space.

Student Worksheet

WHAT HAPPENS TO SOLAR ENERGY?


100 % solar radiation
Atmosphere reflects 34%
Atmosphere absorbs 19%
47% reaches earth's surface and is absorbed

Less than 25% of solar radiation reaching earth's surface is converted by photosynthesis.



Fossil fuels contain stored energy from the distant past. The result of plants and animals buried and transformed into coal, oil and natural gas over millions of years.

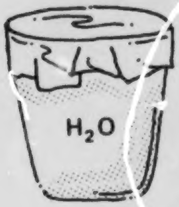
408

Source: United States Department of Energy

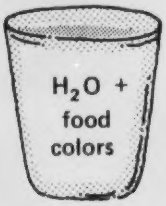
Student Worksheet

HOW MUCH SOLAR HEAT COMES FROM THE SUN TO YOU?

1. Fill two foam cups with a measured amount of cold water.

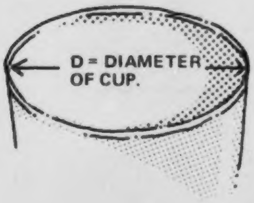


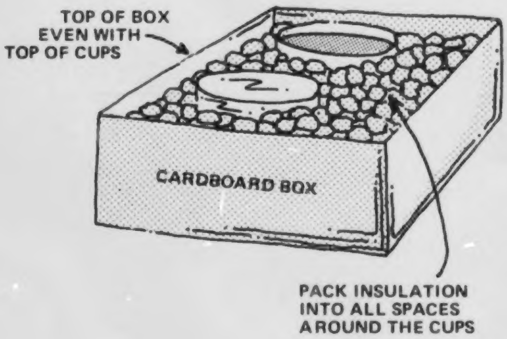
Cover this cup with aluminum foil to reflect sunlight.



Add food colors to the water in this cup to make the water as dark as possible to absorb sunlight.

2. Trim a cardboard box to the same height as the cups.
3. Put the cups in the box and add insulation material.
4. Put the box in the sun for 10 minutes. (Noon to 1 p.m. is usually hottest).
5. Stir the water in the cups with thermometers and record the temperatures.





6. Do this calculation:

Area $= \frac{\pi d}{4}$ = ________________ square centimeters

$$\text{Calories} = \frac{\text{ml of water in cup} \times \text{difference in temperatures of both cups after being in the sun for 10 minutes}}{\text{Area (square centimeters) of water} \times 10}$$

The "calories" calculation is the amount of solar heat received on one square centimeter in one minute at your location.

Multiply x 10,000 to get the results for one square meter.

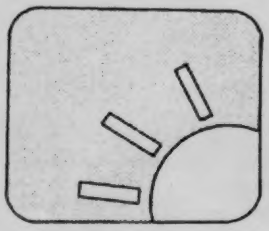
Scientists have measured the amount of solar energy beyond our atmosphere at about 2.0 calories per square centimeter per minute. About 1.5 calories per square centimeter per minute reaches earth after passing through our atmosphere. This is called the Solar Constant.

7. What percentage of the total amount of solar energy is available at your location?
8. Would you have enough energy to heat your house if the south side of your roof was covered with solar collectors.
9. Can you think of a more accurate way to do this experiment?
10. Where do you think most of the errors exist in this experiment?

Source: United States Department of Energy

Student Worksheet

SOLAR FACTSHEET



Solar Energy and You:

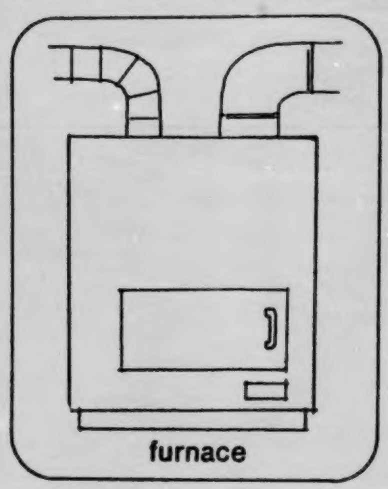
Solar energy is heat and light that comes from the sun. Thousands of years ago some people used this energy to heat their homes. Today, solar energy is again helping to heat buildings.

Why is everyone interested in solar energy now? The reason is that the fuels we burn in our furnaces are very expensive, and the supply of these fuels is shrinking everyday. People are trying to find new ways to heat their homes, factories, offices, and schools without using so much expensive oil and natural gas.

But before you learn how the sun can provide heat for buildings, there are a few facts about your home's heating system that you should know.

How is Your Home Heated?

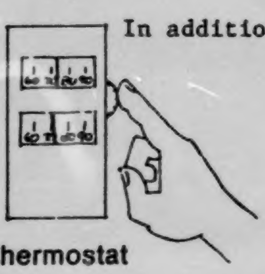
Houses are warm in the winter, but where does the heat come from? Most of the heat comes from burning fuel. The logs on a campfire or in your fireplace are a type of fuel, and the fire itself is a heat source. The heat source keeps your home warm.



furnace

What is the heat source in your home? Many house and apartment buildings have a type of large stove called a furnace in the basement. The furnace burns fuel and is the heat source for the whole building. Some furnaces burn wood or coal for fuel, but most of them burn oil or natural gas to produce heat. Some houses do not have furnaces. Their heat is produced from electricity.

A campfire or fireplace can heat only the space that is right around it. However, the heat from the furnace must heat all the rooms in a house. How does it work? The heat produced by the furnace is used to warm either water or air. Then pumps move the hot water or air to the rest of the house in water pipes or special large tubes for air called air ducts. This movement of the hot water or air to warm other rooms is called heat distribution.



thermostat

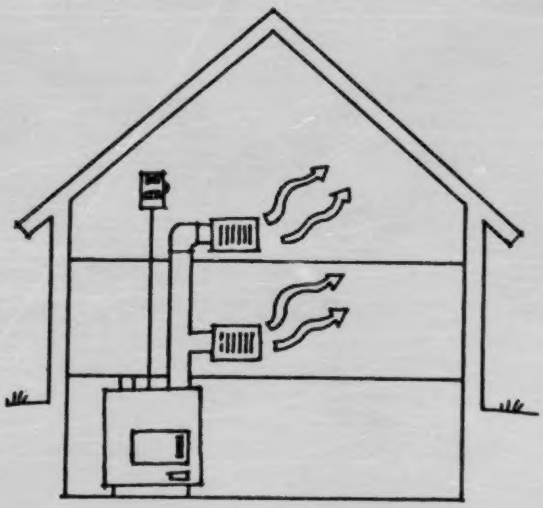
In addition to a heat source and a heat distribution system you need a way to control the amount of heat in your house. Then the rooms won't be too hot or too cold. How can you communicate with a furnace when you need more heat? Maybe you have noticed a small box with a dial inside that is mounted on the wall at home or at school. This box is called a thermostat. It measures the room temperature and signals the furnace to send more or less heat.

Source: National Solar Heating and Cooling Information Center

Student Worksheet

SOLAR FACTSHEET
(Continued)

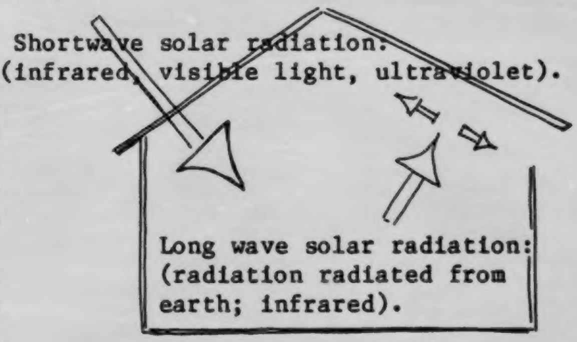
Typical Heating System



How Can Solar Energy Help?

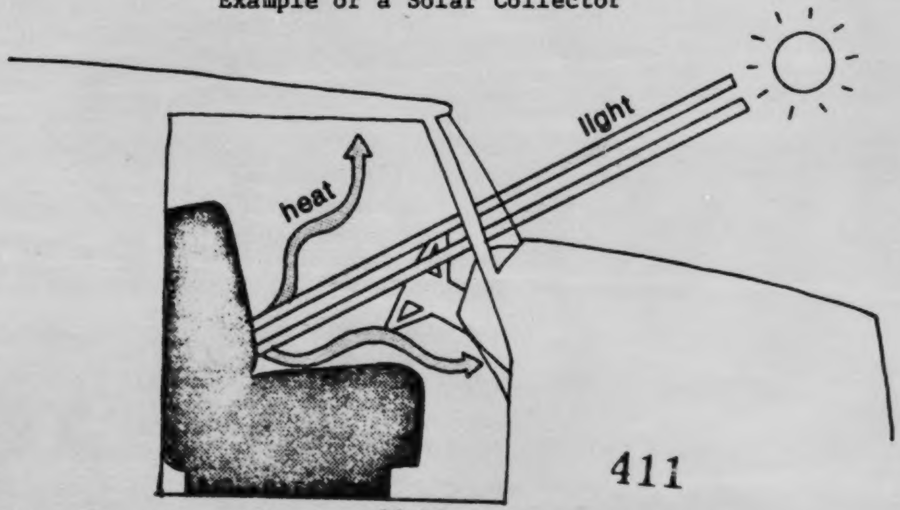
The Sun is a giant heat source. If one can collect enough solar heat, it can be used instead of the heat from a furnace. One way to collect heat is to trap solar energy with solar collectors. An example of how a solar collector works is a car that has dark seat covers and has all its windows closed tightly. When solar radiation (energy) passes through the glass windows of the car, it is absorbed (taken in) by the dark seat covers, walls and floor. Solar radiation that is absorbed changes into heat. If the seat covers are a pale color such as white or yellow, they will not absorb as much sunlight. So pale-colored seats do not become as hot as dark seats. This type of solar collection is known as the "greenhouse effect."

Now here is an interesting fact about glass: it lets light in, but it does not let all the heat out. Even if it is cold outside, the inside of the car will be warm from the trapped heat. So a solar collector does three things: 1. It allows sunlight inside through glass (or plastic); 2. It absorbs the sunlight and changes it into heat; and 3. It traps most of the heat inside.


Shortwave solar radiation:
(infrared, visible light, ultraviolet).
Long wave solar radiation:
(radiation radiated from
earth; infrared).

Greenhouse effect

Example of a Solar Collector



Student Worksheet

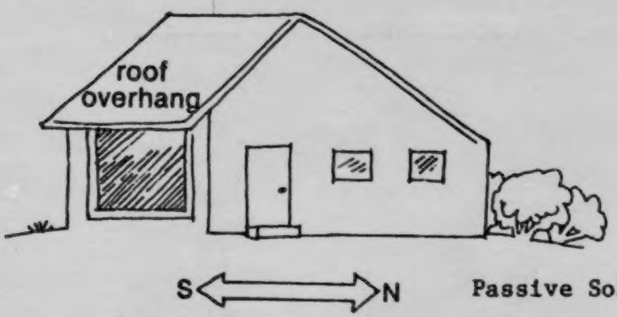
SOLAR FACTSHEET
(Continued)

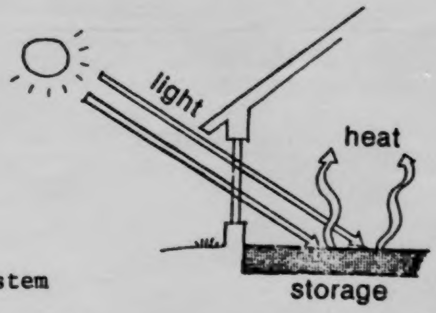
Solar collectors become so hot that they can be used as heat sources for a building. There are two kinds of systems that use solar collectors as heat sources: passive solar systems and active solar systems.

What Are Passive Solar Houses?

In some cases, a whole house itself is a solar collector (just like the car). These houses are called passive solar homes because they don't use any special mechanical equipment such as pipes, ducts, fans or pumps. Since the sun shines from the south in the Northern Hemisphere, passive solar houses are built so that most of the windows face south. They have few or no windows on the north side.

Some passive homes have greenhouses attached to them to let in light and trap the heat. The greenhouse is also used to grow plants because its many windows provide a lot of sunshine for the plants. Most passive houses have thick, dark walls and floors to absorb solar energy and turn it into heat. Passive homes do not use a mechanical heat distribution system. Instead, a passive home works because hot air is lighter than cold air. Because it is lighter, the hot air will naturally rise to the top of a room, leaving the cold, heavy air near the floor. In a passive home, air that is heated downstairs will naturally flow upstairs. Cold air will flow downstairs and be heated up again.





Passive Solar System

To control the amount of heat in a passive solar house, people close doors and windows to keep heated air in and open doors and windows to let heated air out. At night, special heavy curtains or shades are pulled over the windows to keep the daytime heat inside the house. In the summertime, awnings or roof overhangs help to cool the house by shading the windows from the high summer sun.

Some people cannot design their houses to use solar energy this way. They too can use the sun for heat by choosing an active solar system.

What Are Active Solar Houses?

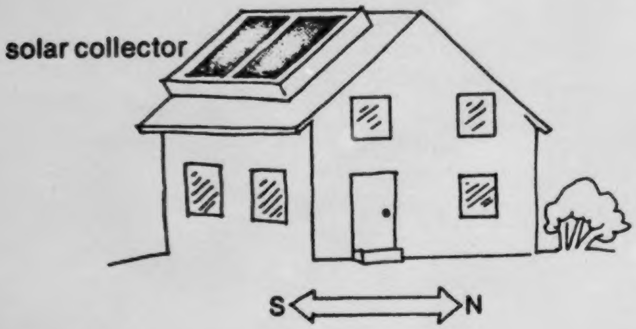
Some buildings do use special mechanical equipment to collect and distribute solar heat. These buildings have active solar heating systems. Active systems use collectors which look like boxes covered with glass. Dark colored metal plates inside the boxes absorb sunlight and change it into heat.

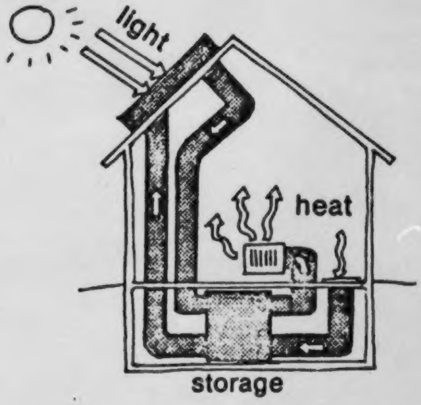
Air or water flows through the collectors and is warmed by this heat. The warmed-up air or water is then distributed to the rest of the house just like in an ordinary furnace system. Thermostats are also used to control the delivery of heat in active solar heating systems. Active solar collectors are usually placed high up on roofs where they can collect the greatest amount of sunlight.

Student Worksheet

SOLAR FACTSHEET
(Continued)

They are put on the south side of the roof in a place where no trees or tall buildings will shade them.




Active solar house

Storing Solar Heat

When a furnace is used to heat a building, you don't need to store any heat as long as there is more fuel. Whenever heat is needed, you simply turn on the furnace. But when a solar heating system is used, what will happen at night or during cloudy weather when no sunlight can be collected? Solar energy systems must include some ways of storing the heat that was collected during sunny weather.

In active systems, either hot water is moved to large tanks of water, or hot air is moved to bins of rocks beneath the building. When it is needed, the hot water or air is taken back out of storage and sent to the living area.

In a passive house, heat is absorbed by the thick walls and floors during the day. At night, when it becomes cold outside, warm walls and floors release their heat back into the room. If you have ever leaned up against a sunny brick wall or dark rock on a cold day, you were leaning on warm solar storage.

Houses with active or passive solar heating systems also have a furnace, wood burning stove, or some other heat source to provide heat in case there is a long period of cloudy weather. This is called a backup heating system.

Other Uses of Solar Energy

Solar energy can be used in many other ways besides heating buildings. Solar photovoltaic cells change sunlight directly into electricity; solar energy heats water for homes and businesses; and sunlight can even be used to cook food. As our supplies of precious natural gas and oil get smaller, we will find new uses for energy from the sun.

Student Worksheet

SOLAR FACTSHEET
(Continued)

Answer the following questions from your readings:

1. What is the definition of solar energy?

2. What are four kinds of fuels?

3. Explain each of these parts of a heating system:
   a. heat source
   b. heat distribution
   c. heat control

4. Which car would be the best example of a solar collector? A car that has:
   a. black seats and its windows open?
   b. dark blue seats and its windows closed?
   c. white seats and its windows closed?

5. Explain your answer to question #4.

6. Describe a house with a passive solar system.

7. Describe a house with an active solar system.

8. Which kind of house do you prefer? Why?

9. Why must solar energy systems have heat storage?

10. What can solar energy be used for besides heating buildings?

Student Worksheet

SOLAR FACTSHEET
ANSWER SHEET

1. Heat and light that comes from the sun

2. Natural gas, oil, coal, wood

3. a. The heat source is what produces the warmth. For example, in a fireplace, the fire itself is a heat source.
   b. Heat distribution is the movement of heat from the heat source to other areas. For example, the movement of hot air thorough a duct from a furnace to other rooms in a house.
   c. Heat control is a way of keeping rooms from becoming too hot or too cold. For example, a thermostat measures room temperature and signals the furnace to send more or less heat.

4. b. dark blue seats and windows closed.

5. The dark seats absorb the heat and the closed windows trap the heat.

6. No special mechanical equipment; most of the windows face south (in Northern Hemisphere); thick, dark walls and floors; special heavy curtains or shades; awnings or roof overhang to block summer sun.

7. On the south side of the roof there will be a glass box with dark metal plates that contains a tranfer fluid, such as air or water. Ducts transport this heated transfer fluid throughout the house, while delivery is controlled by a thermostat.

8. Answers vary

9. For cloudy days and nights when no solar energy can be collected

10. Produce electricity; heat water; cook food

LESSON #34

CATEGORY: Sources

ENERGY TYPE: Direct Solar

TITLE: What is Solar Energy?

GRADE LEVEL: 7-10

INFUSE WITH SUBJECT AREA:
Science

TIME NEEDED: Three periods

MATERIALS:

1 solar collector
6 beakers
Water
2 chocolate bars
2 teabags
6 thermometers
Resource books on solar energy
1 prism
1 spectroscope
1 light socket with a 300 watt standard incandescent bulb and a 300 watt infrared bulb
1 flourescent light source
Suspension of graphite in alcohol
2 cm x 6 cm piece of thin metal sheet
Meter stick and pair of meter stick optic bench stands
Glass jar with lid
One-hole stopper
1 100-watt incandescent blub

OBJECTIVES:

1. The students will understand the meaning of solar energy.
2. The students will examine some of the effects of solar energy.
3. The students will compare the sun's energy to the energy of a 100-watt light bulb.

TASK ANALYSIS:

The students should be able to follow directions to construct apparatus; graph data; read a thermometer; and do basic math computations.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 34.4 - 34.9.
   Read Teacher Background Information (34.3).
   Gather above-listed materials.

2. Steps in Lesson
   Objective #1: The students will understand the meaning of solar energy.
   a. Describe ways in which a knowledge of solar energy is important to students' way of life.
      -Overexposure: skin cancer, sunburn.
      -Energy source for natural systems: weather, plant life, etc.

-Limiting factor for human activity: available energy which can be harnessed by man has implications for energy conservation, change of life style or new ways for harnessing solar energy.

b. Have students name each type of energy in the electromagnetic spectrum and its use by or effect on man. (Cosmic rays, x-rays, ultraviolet rays, visible light, infrared and radio waves).

c. Have students plan an experiment to win a hot water contest. Each lab group will be provided with a thermometer, a 300-watt incandescent light bulb and a jar of water. The object will be to see which group can raise the water temperature the most using only the bulb as a source of energy. They may do research and bring in other material. Have students keep a written record of their plan. On a sunny day, the sun's energy may be substituted for the electric light bulb.

d. Hand out Student Worksheet 34.4. Have the students do the activity working in small groups. Discuss the answers as a group.

Objective #2: The students will examine some of the effects of solar energy.

a. Share with the students the information found on Teacher Background Information (34.3).

b. Hand out Student Worksheets 34.5 - 34.7. Have the students do the activity working in small groups. Compare the results in class.

Objective #3: The students will compare the sun's energy to the energy of a 100-watt light bulb.

a. Hand out Student Worksheets 34.8 - 34.9. Have the students work in small groups to complete the activity.
Compare the results in class discussion.

3. Evaluation

Check answers to Student Worksheets
Check how well apparatus works

4. Follow-Up Activities

Have the students read further to find out how the sun produces its energy.
Research is being conducted to use here on earth the same energy-producing process, fusion, that takes place on the sun. Have students do research on the latest developments in fusion research.

TEACHER BACKGROUND INFORMATION

SOLAR ENERGY

Source:

Southern Solar Energy Center. Solar Energy Project. United States Department of Energy: Washington, D.C. 1979.

The sun is made up of a very large amount of different gases. Helium makes up 25 percent of the sun's mass; hydrogen gas makes up 74 percent; one percent is made up of small amounts of all the other known chemical elements. The weight of all the matter in the sun creates a great pressure within the sun's core. This pressure is nearly one billion times the air pressure at the earth's surface.

Such high pressure and temperature cause four hydrogen nuclei to join and form a helium nucleus. This process of small nuclei joining to form a single larger helium nucleus is called fusion. It is this process of hydrogen fusion that starts the formation of solar energy.

The helium that is produced has a little less mass than the four hydrogen nuclei had together. The small amount of the missing hydrogen mass seems to be changed into a large amount of energy.

This change of mass to energy takes place deep inside the sun. The energy produced inside the sun makes its way to the surface. At the surface, gases absorb the energy and become hot and give off radiant energy. Radiant energy travels away from the sun at a speed of 186,000 miles per second. This means that radiant energy travels from the sun to the earth in about 8 minutes.

The sun sends out radiant energy of all kinds. Most of the energy leaving the sun is in the form of visible light and infrared rays. Together they account for more than 90 percent of the energy produced by the sun. Most of the remaining 10 percent is accounted for by ultraviolet rays, x-rays and gamma rays. Not all of the sun's radiant energy reaches the earth's surface. The earth's atmosphere absorbs harmful x-rays, gamma rays and most of the ultraviolet rays. The solar energy that does reach the surface of the earth is visible light for the most part. A small amount is in the form of infrared and ultraviolet rays.

The sun gives off energy and tramits it to the earth at a rate of 1.94 $cal/cm^2/min$. As this energy is transmitted 19 percent is absorbed by the atmosphere, 34 percent is reflected by clouds, snow, water or land and 47 percent is absorbed by the earth's surface. The total solar energy falling upon the earth is very much greater than current or projected demands for energy. (The energy the sun sends the earth each year is equivalent to 120 millions tons of coal).

At the present time, the problem is how to effectively collect and store this energy at a reasonable cost. A solar collector itself is simple to operate and relatively easy to install.

Student Worksheet

WHAT IS SOLAR ENERGY?

1. Direct sunlight through a prism onto a sheet of paper. Draw a labeled diagram to describe what you observe.

2. Use reference books to read about the visible spectrum. Next to your first diagram make another labeled diagram to show the visible spectrum shown in your reference book.

3. Point your spectroscope to the side of the sun and draw a labeled diagram of what you observe. NEVER LOOK DIRECTLY AT THE SUN EVEN THROUGH A SPECTROSCOPE. Point your spectroscope toward a fluorescent light and draw a labeled diagram of what you observe.

4. a. Place a black bulb thermometer on the lab counter and hold a 300-watt incandescent lamp .5m directly above the black bulb for 5 minutes. Record the temperature.
   b. Allow the thermometer to return to room temperature and then repeat the same procedure using a 300-watt infrared bulb. Record the temperature at the end of 5 minutes.

5. Use reference books to locate a graph showing the intensity and type of solar radiation that reaches the earth and record the information in your notebook. Place a copy of the graph in your notebook.

Answer the following questions:

1. What evidence have you seen that suggests sunlight contains different types of radiant energy?

2. Describe ways in which your two diagrams are alike. Should they be about the same?

3. Compare the color pattern of sunlight and the fluorescent light. How are they different? Do all light sources give off the same type of radiant energy?

4. Which thermometer recorded the highest temperature?

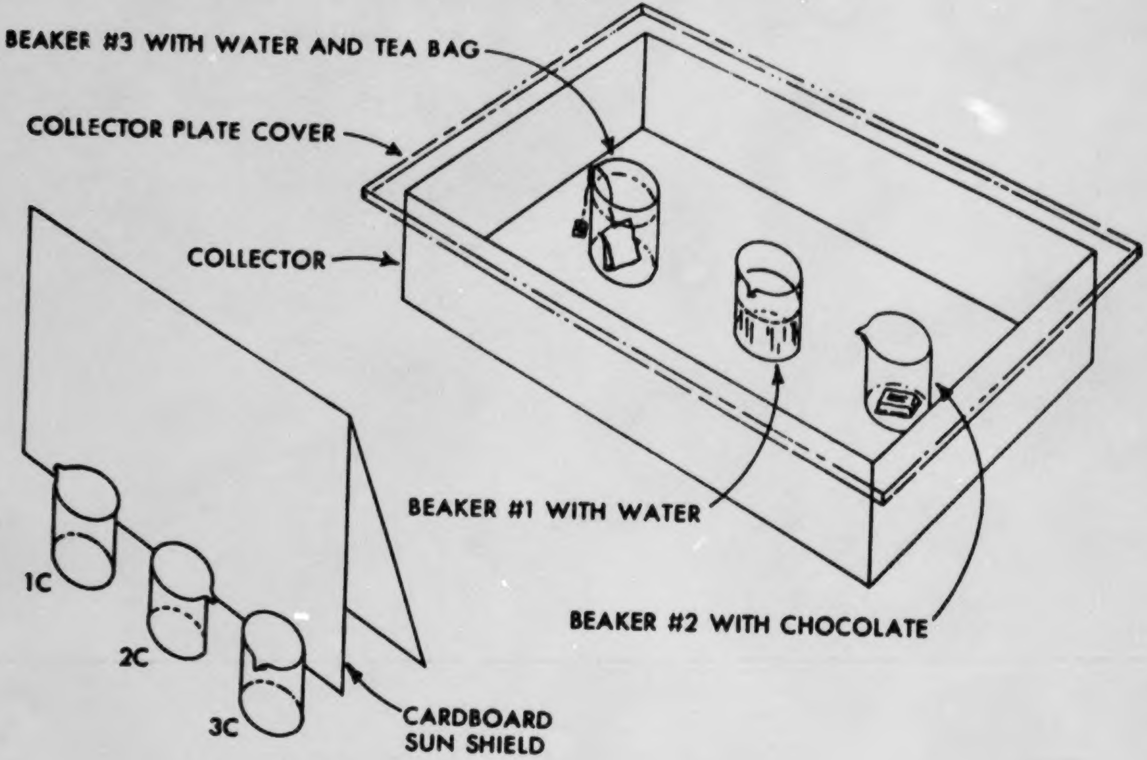
5. Refer to your graph: the distribution of the sun's energy reaching the earth is about 5 percent in the ____________________ region, 40 percent in the ____________________ region and 55 percent in the ______________________ region.

419

Source: United States Department of Energy

Student Worksheet

EFFECTS OF SOLAR ENERGY


BEAKER #3 WITH WATER AND TEA BAG
COLLECTOR PLATE COVER
COLLECTOR
1C
2C
3C
BEAKER #1 WITH WATER
BEAKER #2 WITH CHOCOLATE
CARDBOARD SUN SHIELD

Method:

1. Set up the solar collector so that it effectively catches the sun's rays.

2. Label 6 beakers as follows: 1, 1C, 2, 2C, 3, 3C. The beakers marked with C will be our control.

3. Put a thermometer into each beaker.

4. Place the following substances in the following beakers.

   1 & 1C - water
   2 & 2C - chocolate bar
   3 & 3C - water and tea bag

5. Place beakers 1C, 2C, and 3C in the shade. Place beakers 1, 2, and 3 in the collector.

6. Observe the physical appearance of each substance and record your observations in Data Table 1.

Student Worksheet

EFFECTS OF SOLAR ENERGY
(Continued)

DATA TABLE 1

BEAKER	INITIAL OBSERVATIONS	FINAL OBSERVATIONS
1		
2		
3		
1C		
2C		
3C		

7. Take the temperature of the substance in each of the six beakers every half hour for two hours. Record this information in Data Table 2.

DATA TABLE 2

TIME (MIN.)	TEMPEATURE IN BEAKERS °C					
	1	2	3	1C	2C	3C
0						
30						
60						
90						
120						

8. After two hours make a second observation of the physical appearance of each substance and record it in Data Table 1.

9. On a large piece of paper, graph the data from Data Table 2 using time on the horizontal axis and temperature on the vertical axis.

Source: United States Department of Energy

Student Worksheet

EFFECTS OF SOLAR ENERGY
(Continued)

QUESTIONS

1. What conclusions can be drawn from the graphs?

2. Compare the final temperature and appearance of the water in beaker 1 and beaker 1C.

    a. Was there any difference?
    b. How do you account for any difference observed?
    c. Do you see any way that you could use the information that you gained in this experiment in your home?

3. Compare the final temperature and appearance of the chocolate bar in beaker 2 and beaker 2C.

    a. Was there any difference?
    b. How do you account for any difference observed?
    c. Do you see any way that you could use the information that you gained in this experiment in your home?

4. Compare the final temperature and appearance of the water and tea bag in beaker 3 and beaker 3C.

    a. Was there any difference?
    b. How do you account for any difference observed?
    c. Do you see any way that you could use the information gained in this experiment in your home?

LOOKING BACK

In a short period of time using a simple solar collector you were able to change both the physical appearance and temperature of some common substances. If we were able to use this technique on a large scale, think of the sun's potential as a source of energy.

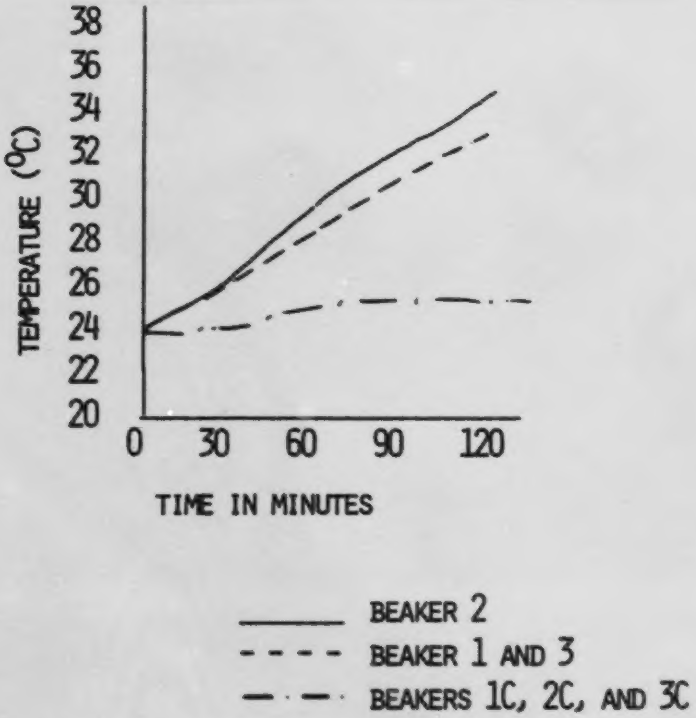
Student Worksheet

EFFECTS OF SOLAR ENERGY
ANSWER SHEET

A flat plate collector can be made simply by painting a large wooden or cardboard box black both inside and out and covering it with a piece of glass or plastic wrap. Make sure that the flat plate collector you will use or construct is deep enough to accommodate 3 beakers.

DATA TABLE 1

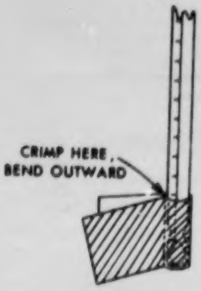
BEAKER	INITIAL OBSERVATIONS	FINAL OBSERVATIONS
1	clear water	water & bubbles
2	firm chocolate	melted chocolate
3	clear water, tea bag	water tea-colored
1C	clear water	no change
2C	firm chocolate	no change
3C	clear water, tea bag	slight diffusion of tea



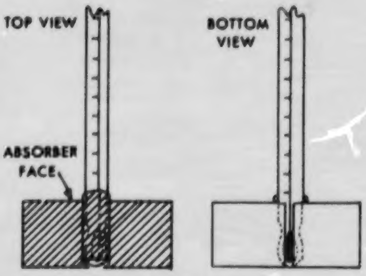
Student Worksheet

HOW DOES SOLAR ENERGY COMPARE?

1. Fold the center of a metal sheeting around a thermometer bulb so that the ends line up evenly.
   Then crimp the sheeting in so that it completely surrounds the bulb. Use the straight edge of a thin plastic ruler to bend the ends of the sheeting outward 90 degrees to form absorber faces.



2. Paint the face of the absorber with a graphite suspension.
3. Insert the top of the thermometer upward into a stopper and then insert the stopper into a jar lid.
4. Place a lid on the jar and adjust the thermometer tube so that the absorber is in the middle of the jar. Your solar collector is now complete.



5. Position the collector so that the absorber faces directly into the sun. Record the maximum temperature.
6. Allow the collector to cool to room temperature.
7. Position the collector at the 50 cm mark of the optical bench. Slowly advance the collector, 1 cm at a time, toward a lighted 100-watt bulb. Stop when the same temperature as that obtained in Step 5 is reached and maintained for two minutes.
8. Record the distance between the filament and the absorber plate.

Student Worksheet

HOW DOES SOLAR ENERGY COMPARE?

9. Determine the sun's relative wattage by using the following equation:

$$\frac{\text{watts (sun)}}{d^2\ \text{(sun)}} = \frac{\text{watts (bulb)}}{d^2\ \text{(bulb)}}$$

d = distancce in meters
d(sun) - 1.50×10^{11} meters

10. Determine the number of 100-watt light bulbs that would equal the sun's wattage.

11. Using the results obtained by each team, calculate the class average of the sun's wattage.

12. Determine the percent of error in the class average by using the following equation and the accepted value for the sun's wattage:

Accepted value - 3.70×10^{23} watts

$$\%\ \text{error} = \frac{\text{experimental (class average) - accepted value}}{\text{accepted value}} \times 100$$

With the use of this relatively simple apparatus you have collected data and made a mathematical determination of the sun's wattage which turned out to be a very large value. From this you determined the number of 100-watt bulbs which would equal the sun's wattage.
Would it be possible to turn on this many light bulbs at once?

Answer the following questions:

1. Why is an incandescent light bulb used instead of a flourescent bulb?
2. Would your location (latitude) and the time of year affect the results?
3. After completing this activity what is your definition of a watt?

Source: United States Department of Energy

Student Worksheet

HOW DOES SOLAR ENERGY COMPARE?
ANSWER SHEET

The wattage of the sun can be determined experimentally by the use of the inverse square law. Students record the maximum temperature produced by the sun in a simple collector and then duplicate this temperature in the lab using a 100-watt bulb. By measuring the distance in meters between the bulb and the collector and equating it to the distance between the sun and the earth, they can determine the sun's wattage.

$$\frac{\text{watts (sun)}}{d^2\text{ (sun)}} = \frac{\text{watts (bulb)}}{d^2\text{ (bulb)}}$$

The scientifically accepted value for the sun's wattage is 3.70×10^{23} watts. This would require 37×10^{22} 100-watt light bulbs to equal the sun's energy. It is to be expected that the percent of error may be quite large.

An electric calorimeter jar of 10 cm^3 will reach 50 degrees centigrade. This same temperature can be obtained in the range of 5 to 12 centimeters from the filament of a clear bulb.

If 10 centimeters is used as a sample distance from the filament, then the sun's wattage would be 2.25×10^{26} watts. The number of 100-watt light bulbs needed to match this wattage would be 2.25×10^{24}. The precentage of error in this measurement would be 39.2 percent.

An advanced class may wish to answer the following questions:

1. If the sun's output were to increase to 10^{25} watts what environmental changes might occur on the earth?
2. If the earth's distance from the sun were increased to 1.5×10^{12} meters, what would be the environmental effects?
3. If your value for the sun's wattage was incorrect by a factor of 10 from the accepted answer, what would be your percentage error?
4. If both parts of this experiment were to be completed outside of the earth's atmosphere, what differences do you think would occur in the results? Use 3.0×10^5 meters above the surface of the earth (approximately 200 miles) as a possible location for this experiment.

LESSON #35

CATEGORY: Uses

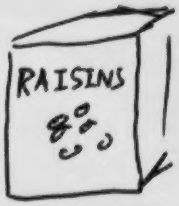
ENERGY TYPE: Direct Solar

TITLE: Food and Solar Energy

GRADE LEVEL: 7-10

INFUSE WITH SUBJECT AREA:
Science
Home Economics
Industrial Arts

TIME NEEDED: Four periods



MATERIALS:
Oven thermometer
Cardboard box
1 sheet rigid foam insulation
1 pane thermal glass
Duct tape
Flat black spray paint
Glue
Plywood; gypsum board
Weather-stripping
Cardboard pieces
Aluminum foil
4 coat hangers
Hot dogs
Scissors
Poster board
Paper clips
Umbrella
Skillet
Grapes
Plastic window screen
String
Food scale
Plastic sheet 1 meter square
Rocks
Collecting can
Shovel
2 thermometers
Timing device
Graph paper
Graduate cylinder
Protractor
Cobalt chloride test paper

OBJECTIVES:

1. The students will learn to calculate the average temperature in a solar oven.
2. The students will cook a hot dog using solar energy.
3. The students will dry fruits using solar energy.
4. The students will collect water to drink using a solar still.

TASK ANALYSIS:

The students should be able to follow directions to construct apparatus.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 35.3 - 35.9.
   Gather above-listed materials.

2. Steps in Lesson
   The Student Worksheets give the teacher a choice of experiments for the students to do (using the worksheet as directions) or for the teacher to do as demonstration.

   Objective #1: The students will learn to calculate the average temperature in a solar oven.
   Hand out Student Worksheets 35.3 - 35.4. Do the activity and discuss the results in class.

   Objective #2: The students will cook a hot dog using solar energy.
   Hand out Student Worksheet 35.5. Do the activity and discuss the results in class.

   Objective #3: The students will dry fruits using solar energy.
   Hand out Student Worksheets 35.6 - 35.7. Do the activity and discuss the results in class.

   Objective #4: The students will collect water to drink using a solar still.
   Hand out Student Worksheets 35.8 - 35.9. Do the activity and discuss the results in class.
   Water will condense from the soil and atmosphere and collect in the container. This water will be distilled and safe for the students to drink.

3. Evaluation

   Taste the food the students have cooked using solar energy.
   Have students calculate the money they have saved by drying their own fruit rather than buying store-dried; or calculate the money saved on electricity, natural gas or propane by cooking with solar energy.

4. Follow-Up Activities

   Have an open house for parents/students/faculty and serve food cooked by solar energy.

Student Worksheet

WHAT IS THE AVERAGE TEMPERATURE A SOLAR OVEN PRODUCES?

Materials

Oven thermometer

Cardboard box, approximately 70cm long x 45cm wide x 35cm high

1 sheet rigid foam insulation, 5cm thick (buy the type with an aluminum foil backing) (local building supply store)

1 pane thermal glass (dimensions depend on size of box - see instructions) (local hardware store or building supply)

Duct tape (local hardware store or building supply)

Flat black spray paint

Glue

Plywood; gypsum board (dimensions depend on size of box; see instructions for base) (local hardware store or building supply)

Weather-stripping (local hardware store or building supply)

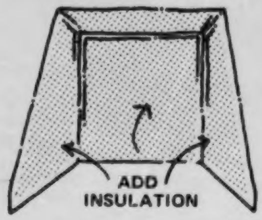
Cardboard pieces

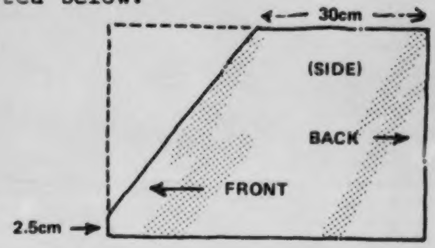
Aluminum foil

4 coat hangers

Prepare the Cardboard Box Frame

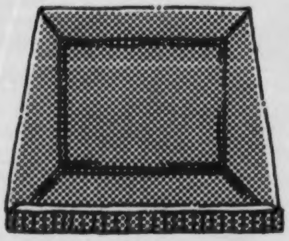
Remove the bottom and one end from the box. Then cut the top and sides as illustrated below.

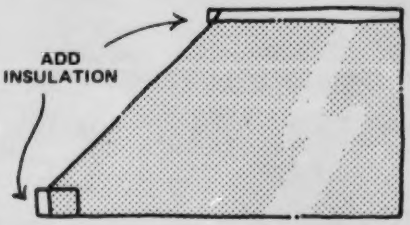




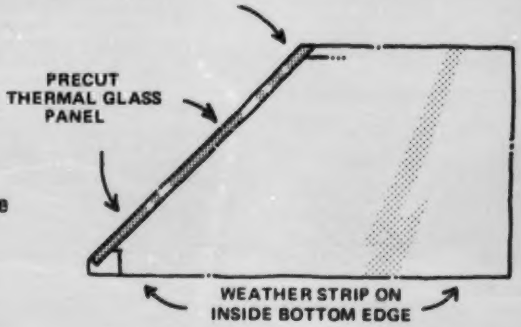
Use the sides and back of the box as a pattern to cut insulation that fits the sides and back of the box precisely. Glue them in with the aluminum foil side against the box.

Now add insulation to the top and front of the box; it should extend about 1.25cm beyond the open edge. Again, glue it into place.





Paint the interior of the box with flat black spray paint to absorb extra heat.
Trim the insulation at an angle so the glass will sit evenly on it.
Add a precut pane of thermal glass to the front of the oven and seal securely with duct tape.
Tape the glass tightly on all edges with duct tape.


PRECUT THERMAL GLASS PANEL
WEATHER STRIP ON INSIDE BOTTOM EDGE

Add weather stripping to the cardboard box frame—use duct tape or glue in place.

Student Worksheet

WHAT IS THE AVERAGE TEMPERATURE A SOLAR OVEN PRODUCES? (Continued)

Conduct Your Experiment Like This:

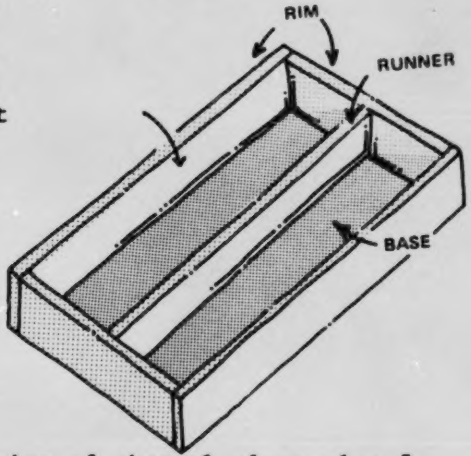
Use the oven thermometer to see how hot your oven gets.

Log the temperature at 10 minute intervals for 1 hour to find the average temperature.

Turn the oven face to follow the sun while you cook.

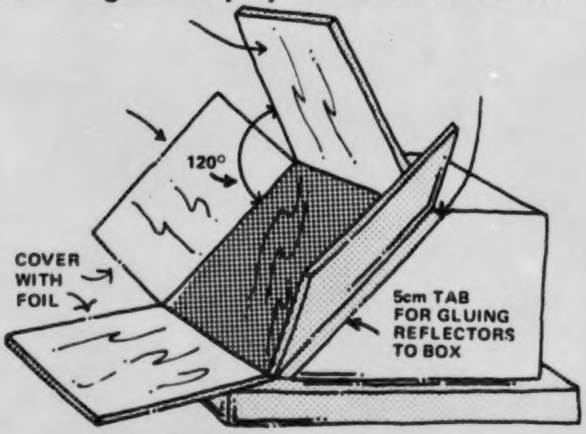
Now Build the Oven Base

Cut a plywood base 5cm longer and 5cm wider than the base of the oven.
Rim the base with more plywood 5cm high, and add a runner down the center.
Fill the spaces with insulation, then cover the entire top of the box with a piece of gypsum board cut the same size as the plywood base.
Paint the gypsum flat black.
Center the oven on top of the base.



Now Add Reflectors

To make reflectors, cut 4 pieces of cardboard the size of thermal glass plus 5 cm larger on one side. This extra 5cm will be creased to serve as a tab to attach the reflectors to the oven.
Cover the reflectors with aluminum foil, shiny side out, attaching the foil with glue.
Use the straightened coathangers to prop the reflectors at a 120° angle to the face of the oven.



Other Ideas to Explore

How long does it take your oven to cook hamburgers?
Would a second pane of glass and more insulation help you achieve a higher temperature?

Source: United States Department of Energy

Student Worksheet

SOLAR COOKING

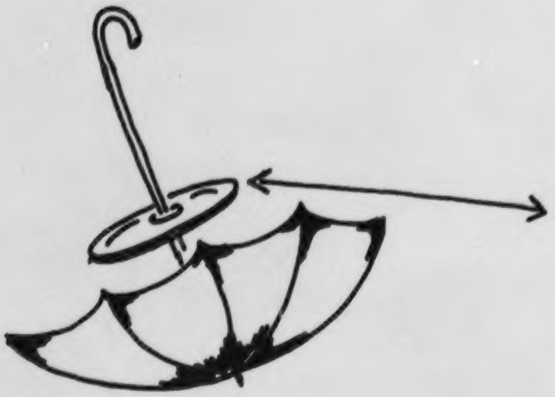
Materials:
Large paper clips
Rubber cement/glue
Umbrella
Poster board
Aluminum foil
Black skillet
Oven thermometer
Hot dogs

Procedure:

Open the umbrella, measure the panels and cut new panels out of poster board large enough to over lap slightly. Cover each post board panel with rubber cement then heavy weight aluminum foil. Use paper clips to mount these panels inside the open umbrella. Measure the radius of the umbrella. Cut off the handle to the same length as the radius of the umbrella. (A string may be used to measure the radius). Use this pointer to direct the umbrella toward the sun. Locate the hot spot (focal point). Put the skillet over the hottest spot and cook the hot dog. To increase efficiency, cut a hole in a paper plate the size of the pointer, cover the plate with foil and lay it over the pointer pushing it down to the center of the umbrella. This helps hold the panels in place.

Example: If the diameter of the umbrella is 36 inches then the length of the pointer should be 18 inches.

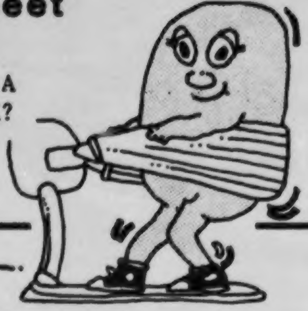
$(\text{radius} = \frac{\text{diameter}}{2})$



Source: Robert Walsh, North Enid, Oklahoma

Student Worksheet

HOW MUCH WEIGHT CAN A GRAPE LOSE IN A WEEK?



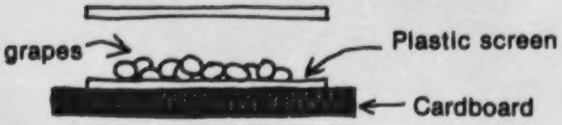
MATERIALS:

from hardware or variety store

¼ lb. Grapes; plastic window screen; cardboard
Masking tape; string; food scale

Cut a large hole in a piece of cardboard.

Tape plastic screen over the hole.
Weigh the grapes.

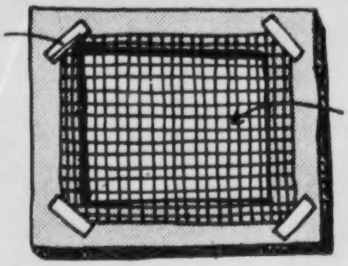


(The top screen protects grapes from birds and insects.)

Weigh raisins before nibbling!

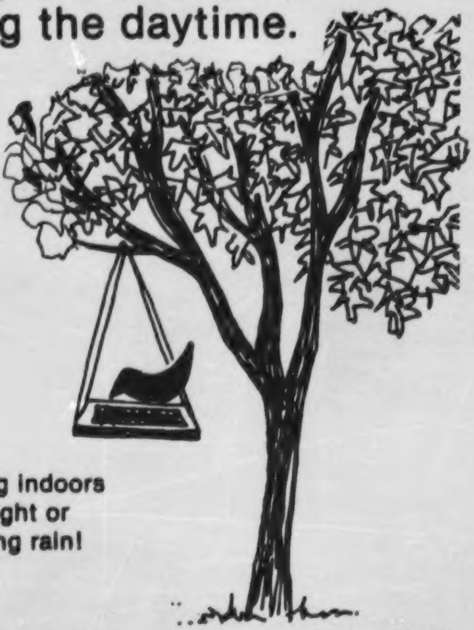
When the grapes look like raisins, remove them. Weigh them again.

Weight of grapes before	Weight of grapes after



Tape the second plastic screen to the first screen to hold the grapes in place.

Hang the cardboard with string in a sunny spot during the daytime.

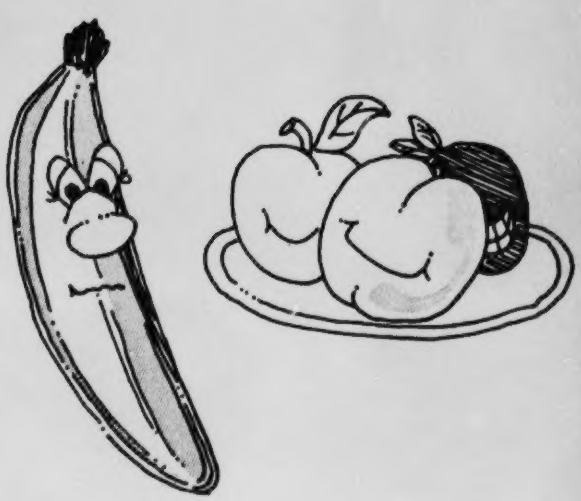


Hang indoors at night or during rain!

Student Worksheet

HOW MUCH WEIGHT CAN A GRAPE LOSE IN A WEEK? (Continued)

Why did the grapes lose weight?



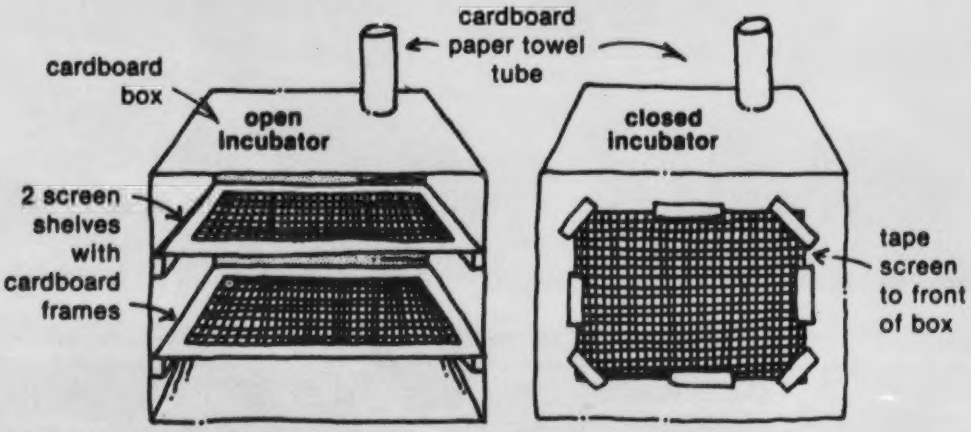
Many fruits can be dried in the sun — especially apricots, prunes, and peaches. If fresh apricots are 59¢ a pound and dried apricots are $2.00 a pound, which is a better buy?

How does drying food preserve it?

Dry fruit using solar energy!

Dried fruit can be stored for long periods of time without losing its food value. However, dried fruit can be more expensive per pound in comparison to the same type of fresh fruit. Many fruits and vegetables including raisins, prunes, and parsley are sun-dried commercially.

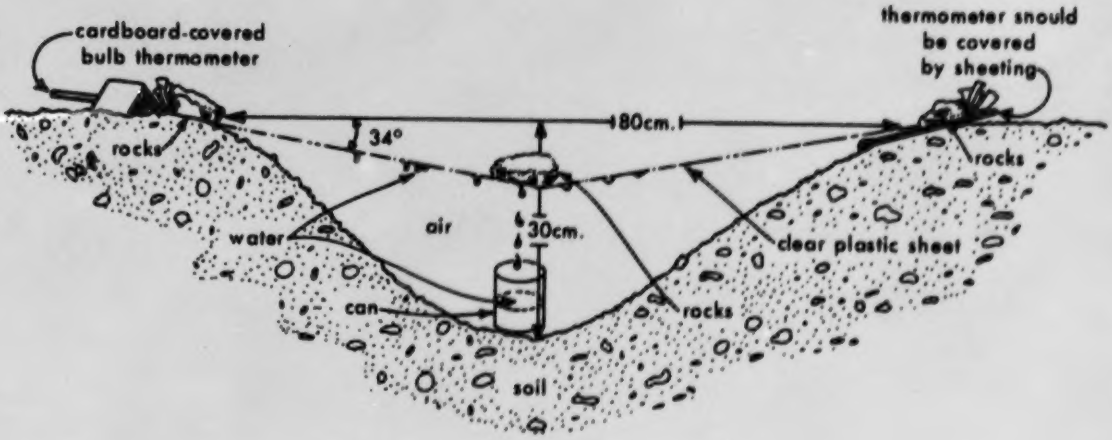
Make an incubator with shelves.
Place the fruit on screen shelves.
Place the incubator in an attic or warm closed area.
Time the incubator until the fruit is dry.


cardboard paper towel tube
cardboard box
open incubator
closed incubator
2 screen shelves with cardboard frames
tape screen to front of box

Source: United States Department of Energy

Student Worksheet

SOLAR STILL


cardboard-covered bulb thermometer
thermometer snould be covered by sheeting
80cm.
34°
rocks
rocks
water
air
30cm.
clear plastic sheet
can
rocks
soil

METHOD:

1. Dig a hole about 80cm in diameter and 30cm deep and place the soil to one side. Center the collecting vessel in the bottom of the hole.

2. Place the piece of plastic over the hole and firmly anchor one edge with small rocks.

3. Place one small rock in the center of the plastic sheet directly over the collecting vessel, and allow the plastic to stretch to at least a 34° angle from the horizontal.

4. Seal the edge of the plastic with soil and small rocks.

5. Insert one thermometer under the plastic sheet with the bulb extending into the air chamber, and positioned so that the scale can be read.

6. Place the other thermometer near the solar still with the bulb covered by cardboard (as shown in the diagram), and positioned so that the scale can be read.

7. Simultaneously record the temperature of both the inside and the outside thermometers at two-minute intervals. Construct a data table to record your results.

Student Worksheet

SOLAR STILL
(Continued)

8. At the end of 20 minutes, carefully remove the plastic shield and retrieve the calibrated collecting vessel. Pour into the graduated cylinder to check the original reading and record the amount of liquid collected in ml.

9. Check the liquid collected to determine its identity; cobalt chloride paper may be used.

10. Construct two graphs with time on the x-axis and the temperature readings on the y-axis, using the same scale.

    a. Have graph I represent the outside thermometer reading vs. two minute intervals.
    b. Have graph II represent the inside thermometer reading vs. two minute intervals.

11. The hole should be filled in when the activity is complete.

LOOKING BACK:

You have seen that it is possible to get water from dry soil using a very simple technique. The evaporation and condensation of water using the sun is a very useful process for producing distilled water.

QUESTIONS:

1. Where did the water come from?

2. Why did it collect on the undersides of the plastic?

3. Why did it drip into the collecting vessel?

4. Compare graphs I and II. Are they similar or different? Explain.

5. How did solar energy cause the still to operate?

6. How did the temperature difference influence the volume of water collected?

GOING FURTHER:

Repeat the activity measuring the amount of water collected as a function of time.

Repeat the same activity with a change in the size of the hole. (Hint: a much deeper, narrower hole, or a wider, shallower hole.)

Source: United States Department of Energy

LESSON #36

CATEGORY: Uses

ENERGY TYPE: Direct Solar

TITLE: Solar Energy and Your Home

GRADE LEVEL: 10-12

INFUSE WITH SUBJECT AREA:
Home Economics
Science
Math

TIME NEEDED: Three to four periods

MATERIALS:
1 insulated model home (See Answer Sheet 36.12a)
2 thermometers
1 roll duct tape
1 watch
1 light source - if day is cloudy
(Optional)
1 carton plastic wrap
1 spray container flat black paint
1 cardboard box
1 carton aluminum foil
1 jar rubber cement
1 small stick of wood
1 quart metal can
1 package rubber bands
1 drill
Scrap wood for 33cm x 72cm x 8cm box
5 meters black vacuum tubing
2 electrical Althread nipples to fit tubing
1 sheet tin or aluminum - 16cm x 20cm
1 package thumb tacks
Several sheets corrugated cardboard
1 spool string or thread
15 small metal cans
Insulating materials.

OBJECTIVES:

1. The students will recognize some advantages of solar technology as an energy source for residential heating and cooling.
2. The students will become familiar with the function of and construct a solar hot water heater.
3. The students will recognize the effects of such factors as: site orientation, roof overhang and landscaping on the efficiency of solar energy systems.
4. (Optional). The students will construct a solar greenhouse and compare its efficiency with that of a conventional greenhouse.

TASK ANALYSIS:

The students should be able to read instructions to construct apparata; do basic math computations; graph material; and read a compass.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 36.4 - 36.19.
   Gather above-listed materials.
   Construct model home.

2. Steps in Lesson
   Objective #1: The students will recognize some advantage of solar technology as an energy source for residential heating and cooling.

   a. Hand out Student Worksheets 36.4 - 36.6. Have students read, then discuss the material.
   b. Hand out Student Worksheet 36.7. Have the students answer the questions independently, then discuss the answers as a group.
   c. (Optional). Have the students determine whether part of their family's energy needs could be met by alternate means such as the installation of solar panels.
      Have the students do research to find out such things as:
      -The total BTU's required for hot water and home heating. (This may be done by having the students look back over their family's utility bills for the past several months).
      -Solar panel output:
       *The number of solar panels required to meet your family's needs.
       *The cost of solar panels, including installation.
       *The life expectancy of solar panels.

   Have the students compare the yearly cost for solar energy with the yearly fuel costs (fuel oil, natural gas, electricity, propane, wood) of their family. Have them include an inflation factor in their calculations.
   Ask: "Would it be worthwhile to install solar panels in your home?"
   The same steps may be taken to do an energy survey of your school if desired.

   Objective #2: The students will become familiar with the function of and construct a solar hot water heater.

   a. Hand out one set of the following Student Worksheets:
      Student Worksheets 36.8 - 36.9 for an advanced class.
      Student Worksheets 36.10 - 36.11 for a lower-level class.
   b. Discuss the Worksheets, then have the students work in small groups to complete the activity.
   c. Discuss, as a class, the results obtained by the students.

   Objective #3: The students will recognize the effects of such factors as: site orientation, roof overhang and landscaping on the efficiency of solar energy systems.

   a. Hand out Student Worksheet 36.12. Have the students work in small groups to complete the activity. Discuss the results obtained as a class.

b. Hand out Student Worksheet 36.13. Discuss the information in class.
c. Hand out Student Worksheets 36.14 - 36.15. Have each student do the activity independently, then discuss the results as a class.

Objective #4: (Optional). The students will construct a solar greenhouse and compare its efficiency with that of a conventional greenhouse.

a. Hand out Student Worksheets 36.16 - 36.17. Have the students work in small groups to complete the activity. Discuss the results as a class.

3. Evaluation

Check student understanding of the effect of site orientation, building structure and landscaping on solar energy efficiency by having them use Student Worksheets 36.18 - 36.19 to construct and landscape a model dwelling. After completion of the dwellings, a display may be set up and students may vote on the dwelling they feel is the most solar efficient.

4. Follow-Up Activities

Have students try to determine the least efficient home and the most efficient home in their area. Have them survey their neighborhood. Ask: "Do you see more of the efficient or inefficient homes?"

Have the students design a solar hot water system for their own homes or for the school.

Have the students do research into the relationships between insulation and solar efficiency using the following activities:

a. Find out what types of insulating materials are used in construction today. Which type seems to be the best insulator?
b. Find out what type insulation is in your home. Does it seem to be effective?
c. Go to a library or lumber yard and find out how insulation is rated as to effectiveness.
c. Have a cool cube contest by designing a container to keep an ice cube cool. Students are given the problem of determining whose ice cube stays the longest in a container they built. (The problem, however, is that the best containers may hold the ice cube for 14 - 15 hours).

STUDENT BACKGROUND INFORMATION
SOLAR ENERGY

Sources:

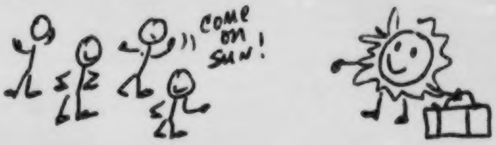
Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

Center for Renewable Resources. Sun Day Fact Sheet and Solar Energy: An Introduction.

By the year 2000, the United States could obtain more than 25 percent of its energy from renewable resources: sunlight, wind, hydropower and biomass.

Reaching this goal would require an ambitious national effort. But this level of solar development need cost no more -- and could cost less -- than would a program to obtain the same amount of energy using nuclear power or synthetic coal-based fuels.

Renewable energy sources, used wisely, have fewer negative environmental consequences than do conventional energy resources. They produce no radioactive wastes; nor do they threaten to trigger a planetary greenhouse effect. Solar sources thend to be labor-intensive, stable and resilient; they tend to foster self-reliance, political and cultural pluralism, and a favorable balance-of-payments. Moreover, used worldwide, renewable resources should discourage the proliferation of nuclear power with its associated weapons potential.



Recent polls report that 94 percent of the American people favor the rapid development of solar sources.

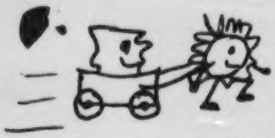
Direct solar energy is one of the most attractive alternative energy sources in Arkansas' future. The amount of energy available for conversion is much greater than all the present energy requirements. Solar energy will likely make only a small contribution to the state's energy supply by 1985; but could make significant contributions at a local level. Statewide contributions will be made when oil and natural gas prices have risen and mass acceptance has reduced installation and other initial costs of direct solar systems.

Question number one: Why has solar energy become so popular?

First of all, using solar energy isn't that new. From the late 1800's until the 1940's a solar hot water boom spread from California to Florida. The popularity of these solar hot water systems declined when electricity proved less expensive. Now, however, the situation is reversing itself. Our society is using up its oil and natural gas at a furious pace. Although the United States has plenty of coal, deep mining is dangerous, strip mining disrupts the environment, and burning coal pollutes the air. Another energy option -- nuclear fission -- is complex and dangerous; plus each plant now costs more than $1 billion to build.

Fortunately, the solar options are more attractive. Sunlight is abundant. The widespread use of solar systems could create safe jobs and fits well into a political system that emphasizes decentralization and local control.

Question number two: What are the most common ways of harnessing solar energy?



Hot water heaters; about 35,000 homes in the United States now heat their water with sunlight.

Direct sunlight can also heat buildings. Passive systems shield a building from summer heat while capturing the sun's warmth during the colder months. South-facing windows and extra-thick masonry walls are common features of passive solar architecture - beyond a doubt the most efficient and cost-effective way to heat and cool new buildings.

Passive solar heating is well adpated to use in Arkansas where the winter temperatures are generally not too extreme.

Active solar systems are more expensive, but they can be bolted onto the roofs or southern walls of existing buildings as a substitute for -- or supplement to -- conventional furnaces. In active systems fans or pumps move solar-heated air or liquid from collectors to storage areas, from which heat is withdrawn as needed. Solar self-sufficiency will require, in most cases, a combination of active and passive features in all but the southern rim of the United States.

A wide variety of active solar heating equipment is available to Arkansans; and is currently being used for hot water heating in many homes throughout Arkansas.

Question number three: Are solar heating systems economical?

Savings Bank

When space heating and hot water systems are compared on a lifetime basis, solar systems are found to be widely competitive, especially when compared with electric heat. The initial investment for a solar system is higher; however, the lower initial cost of the conventional system must be supplemented by high monthly fuel bills. Since 1973, the price of solar equipment has dropped steadily while the costs of all competing energy sources have skyrocketed. Also, in most cases, the return in saved fuel costs on an investment in solar equipment is higher than an interest-earning savings account. Through cost reductions for solar systems and rising fuel costs for the other alternatives, solar systems are economically competitive with all residential fuel types.

Using a well-designed passive system, an Arkansas home owner can save 80 to 90 percent of his heating costs and substantially cut cooling costs.

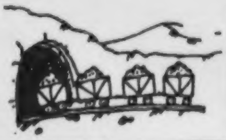
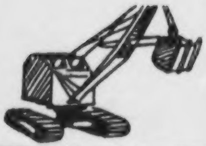
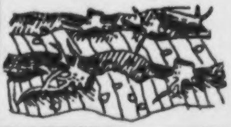
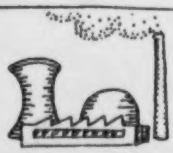
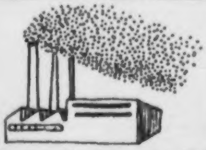
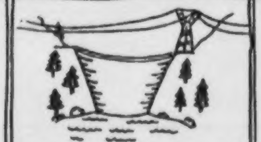
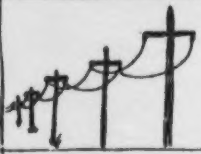
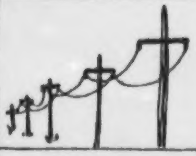
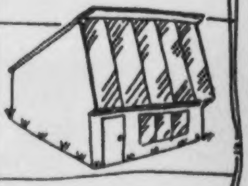
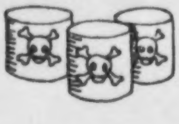
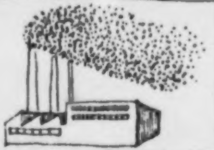
Question number four: Are solar heating systems feasible in all areas of the country?

Passive solar heated homes have been built in all regions of the United States. In cloudy areas solar collectors and storage units need to be larger; the initial cost, therefore, is higher. However, a recent study shows that solar reaches economic viability earlier in the colder Northern states than in the South. This is because heating requirements are greater and conventional energy sources are more expensive in the North. Solar heating systems, therefore, pay for themselves faster in the North because of greater savings in fuel costs.

In Arkansas, a sunbelt sate, 60 to 100 percent of the residential space heating requirements can be met by the use of solar energy.

Student Worksheet

ENERGY STEPS

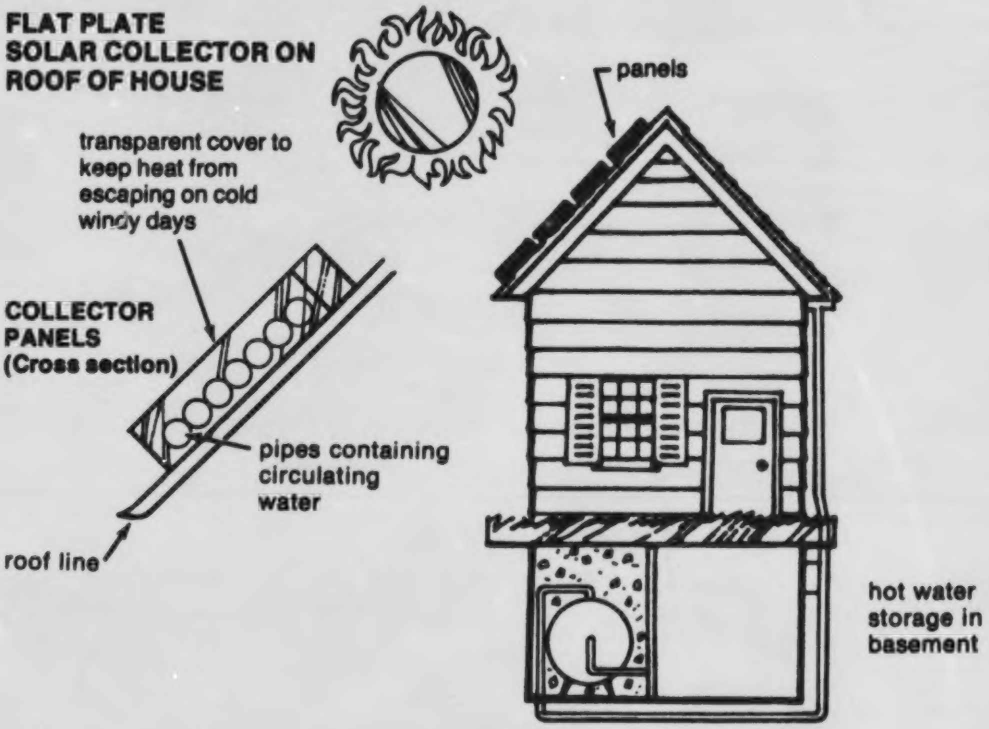
	NUCLEAR FISSION	COAL	HYDRO	SOLAR
MINING				
LAND RECLAMATION				
TRANS-PORTATION				
ENRICHING				
TRANS-PORTATION				
GENERATING				
TRANSMISSION				
WARM HOME				
WASTE & POLLUTION				

Source:

Student Worksheet

ENERGY FROM THE SUN

There are several ways to use solar energy. One way is for each house, apartment or office building to collect enough solar energy to take care of its own heating, air conditioning and water heating, but not its electric power. Another is to build huge solar farms to collect solar energy, turn it into heat and then to electricity that will be sent to individual dwellings. A one-square mile farm of many of these collectors could supply electricity for about 20,000 houses.



FLAT PLATE SOLAR COLLECTOR ON ROOF OF HOUSE

panels
transparent cover to keep heat from escaping on cold windy days
COLLECTOR PANELS (Cross section)
pipes containing circulating water
roof line
hot water storage in basement

1. What parts of the United States and/or Arkansas would be able to use solar heat without a conventional back-up furnace?
2. What side of the roof should the collectors be mounted on?
3. Why is the inside of some types of collectors lined with mirrors?
4. Will the heat from roof collectors be used to generate electricity?
5. Could the heat from solar farm collectors be used to generate electricity?
6. Would it be feasible to set aside 10,000 square-miles of Arkansas land to build a solar farm?
   Would it be just as good to use the land for farming?

7. It has been estimated that by the year 2000, as much as 25 percent of the energy needs of the United States will be filled by solar technologies. Why will it take so long?

Source: United States Department of Energy

Student Worksheet

ENERGY FROM THE SUN
ANSWER SHEET

1. The South/Southwest
2. The south side
3. To reflect and concentrate the rays of the sun
4. No
5. Yes
6. Answers vary
7. Technology; cost; setting research priorities

Student Worksheet

SOLAR HOT WATER SYSTEMS

The basic function of a solar domestic hot water system is the collection and conversion of solar radiation into usable energy. Solar radiation is absorbed by a collector, placed in storage as required, with or without the use of a transfer medium, and distributed to point of use. The performance of each operation is maintained by automatic or manual controls. An auxiliary energy system is usually available both to supplement the output provided by the solar system and to provide for the total energy demand should the solar system become inoperable.

The parts of a solar system may vary widely in design, operation and performance. They may be arranged in numerous combinations dependent on function, component compatibility, climatic conditions, required performance, site characteristics and architectural requirements.

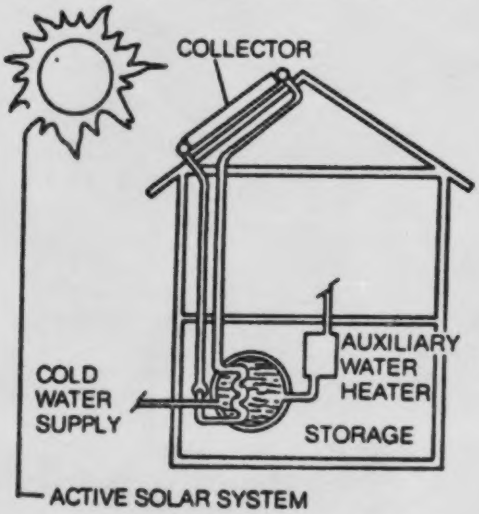
The commonly used flat-plate collector consists of an absorber plate, usually made of metal and coated black to increase absorption of the sun's energy. The plate is insulated on its underside and covered with one or more transparent cover plates to trap heat. The captured heat is removed from the absorber plate by a heat transfer fluid, generally air or water. The fluid is heated as it passes through or near the absorber plate and then transported to points of use, or to storage, depending on energy demand.

The storage of thermal energy is necessary since there will be an energy demand during the evening, or on sunless days when solar collection cannot occur. Heat is stored when the energy delivered by the sun and captured by the collector exceeds the demand at the point of use.

The distribution component receives heat energy from the collector or storage, and dispenses it at points of use as hot water.

The controls of a solar system perform the sensing, evaluation and response functions required to operate the system in the desired mode. For example, when the collector temperature is sufficiently higher than storage temperature, the controls will cause the heat transfer fluid in storage to circulate through the collector and accumulate solar heat.

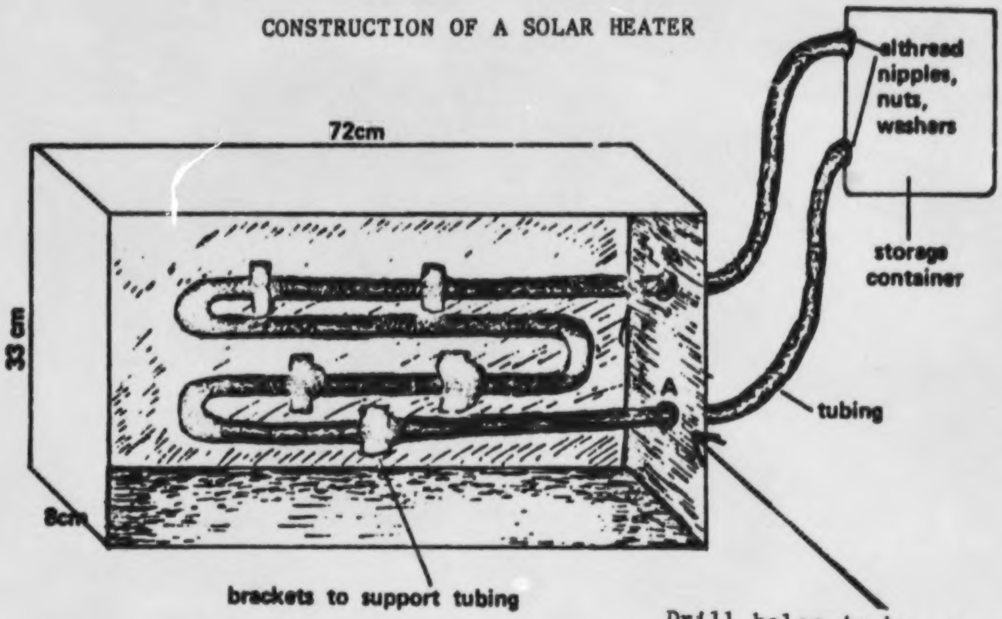
An auxiliary energy system provides the supply of energy when stored energy is depleted due to severe weather or clouds. The auxiliary system uses conventional fuels such as oil, natural gas, electricity or wood.



Source: United States Department of Energy 444

Student Worksheet

CONSTRUCTION OF A SOLAR HEATER



Drill holes in box at point A.

Construction of Collector:

1. Construct a box and paint flat black.
2. Cut 10 tin strips (4cm x 8cm) and paint black.
3. Drill holes in box at point A.
4. Place and anchor tubing in box with black strips and tacks.
5. Put nipples in can or jug so tubing can be attached.
6. Fill system with all the water it will hold. Blow excess air out of tubing. Make top of box with clear plastic.

Use of Collector:

1. Measure temperature of water in reservoir. Set solar box so it will receive maximum sunlight inside the box. Usually, the collector should be pointed south.
2. Measure temperature of water at intervals of 5 minutes.
3. Observe movement of water through the system. Move the system approximately every 20 minutes to maintain maximum sunlight efficiency.
4. Plot a graph of temperature and time.

Discuss the following questions:

1. What is the basic function of a domestic solar hot water system?
2. List the parts of a solar hot water system.
3. What are some factors that may affect the type of system needed for a particular site?
4. What is the purpose in insulating the collector?
5. What is the purpose of painting the collector black?
6. What are some usual heat transfer fluids used in solar collectors?
7. What causes the heat transfer fluid to move?
8. Why is storage important with a solar system?
9. What are some fuels often used to power the auxiliary energy system used with most solar systems?
10. Distinguish between an active solar system and a passive solar system.
11. Can you think of some ways to increase the efficiency of your solar heater?

Student Worksheet

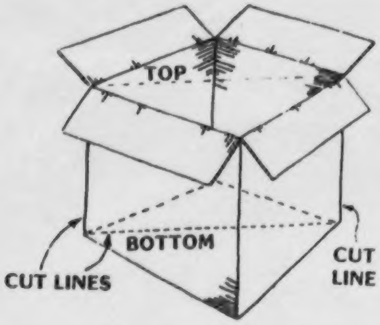
CONSTRUCTION OF A SOLAR HEATER
ANSWER SHEET

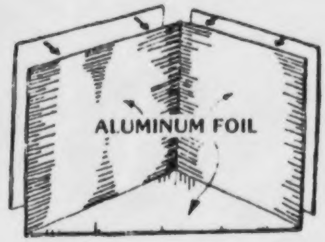
1. Collection and conversion of solar radiation into usable energy
2. Collector, storage, distributor, transport, control, auxiliary energy
3. Climate, needs of family or user, topography, architecture
4. Reduce convective heat loss, trap heat within the collector
5. Black absorbs all the heat possible and increases the efficiency of the collector
6. Air, water
7. The heating of the transfer fluid causes convection currents to be set up
8. For evenings, cloudy days
9. Oil, natural gas, electricity, wood
10. Active uses energy resources other than solar to transfer thermal energy. Passive uses solar energy alone to tranfer thermal energy
11. Answers vary

Student Worksheet

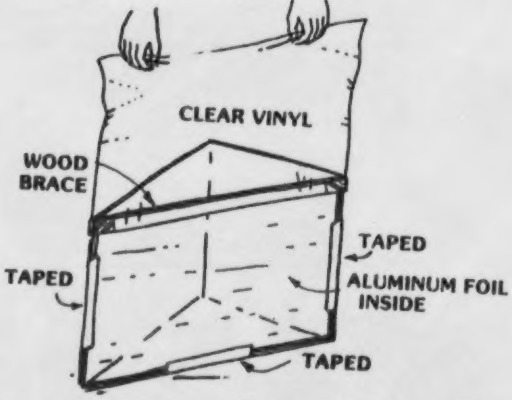
HOW TO MAKE A SOLAR WATER HEATER

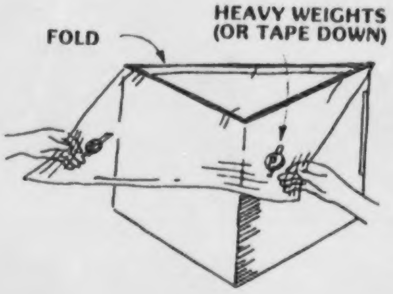
1. Cut a cardboard box in half along the diagonal leaving a triangular shaped top and bottom. Cut off the top triangle. The left-over piece has two sides that can be cut out to fit flat onto the sides of the remaining half-box. Glue aluminum foil to these with rubber cement, then tape them to the sides of the half-box. These side pieces will add thickness to the walls and help retain heat. Cover the bottom with aluminum foil in the same manner as the sides.


TOP
BOTTOM
CUT LINES
CUT
LINE

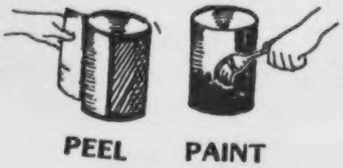

ALUMINUM FOIL

2. Tape a small stick of wood with duct tape across the top corners of the heater box as a brace. Tape plastic wrap to the bottom and sides of the box, making sure it is cut long enough to have some left to fold over the top. This fold-over flap can be used as a door, using heavy weights or tape to hold it shut.


CLEAR VINYL
WOOD
BRACE
TAPED
TAPED
ALUMINUM FOIL
INSIDE
TAPED


FOLD
HEAVY WEIGHTS
(OR TAPE DOWN)

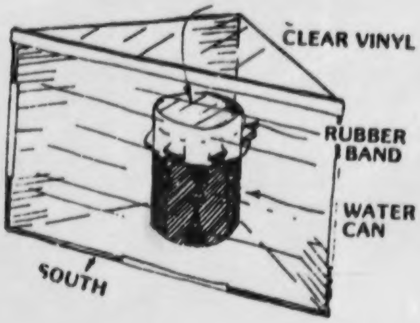
3. Use any can about 1 quart size without leaks. Peel off any labels and rub the can to dull the shiny finish. Paint the can with flat black paint.



Student Worksheet

HOW TO MAKE A SOLAR WATER HEATER
(Continued)

4. Fill the water can, cover the top of it with plastic wrap and wrap a rubber band around the top to seal it. Place the filled can on the bottom of the heater box and close the top flap, sealing well. Face the front of the box to the south and wait for it to heat up. You can test the temperature of the water by sticking a thermometer into it. You can also experiment with different colors or different kinds of water cans and jars.



Answer the following questions:

1. Where does the energy to heat the water come from?
2. Why should a black can be used in this activity?
3. How would changing the color of the can affect the temperature of the water?
4. Under what weather conditions would a solar water heater work best?
5. Can you think of any ways to increase the efficiency of your solar heater?

Source: United States Department of Energy

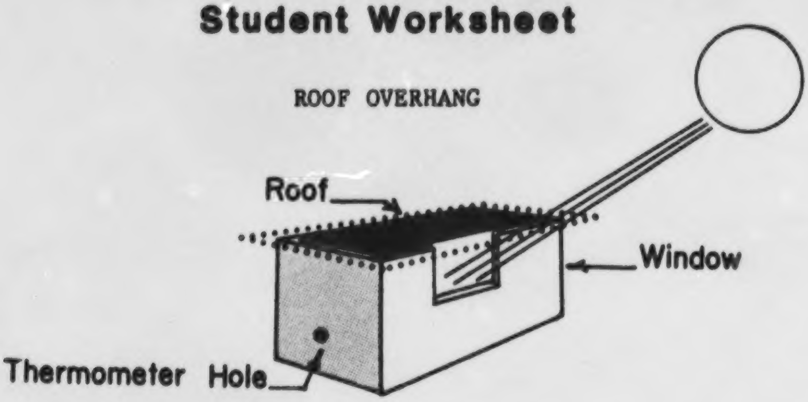
Student Worksheet

HOW TO MAKE A SOLAR WATER HEATER
ANSWER SHEET

1. The sun
2. Black is the most efficient color for heat absorption.
3. It would take longer for the water to heat up.
4. Clear and warm
5. Answers vary

Student Worksheet

ROOF OVERHANG



1. Get an insulated model home from your teacher. The models are fragile and should be handled with care.

2. Make a data sheet such as this one to record all information to be measured.

Time	Temperature (°C)		
	Direct Sunlight	1/2 Shadow	Full Shadow

3. Place a thermometer into the hole at the side of the house; record the temperature on your data sheet.

4. Place the model in direct sunlight and adjust it so that the sun shines directly into the window without the roof overhang casting a shadow on it. If it is cloudy, you can use a heat lamp in place of the sun.

5. Record the temperature inside the model each minute for five minutes on your data sheet.

6. Remove the roof from the house in order to allow the air inside the building to return to the same temperature as the surrounidng air. Fanning with the roof will speed this.

7. Plot the data, temperature versus time, on a graph.

8. Repeat steps 5, 6 and 7 using different amounts of shadow on the window. First, it should be done by adjusting the roof to cast a shadow which covers 1/2 the window, and then it should be repeated where the window is entirely in the shadow. Plot all the information on the same graph.

9. Look at your graph and determine which position of roof overhang would be best if you were interested in keeping your home cool in the summer. What position would be best for keeping your home warm in the winter?

10. In the summer the sun is higher in the sky than it would be in the winter. Explain how this might help or hinder the heating or cooling of your home with roof overhang.

Source: United States Department of Energy 450

Student Worksheet

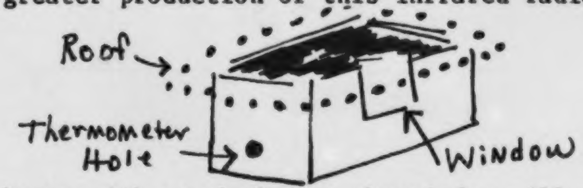
ROOF OVERHANG
ANSWER SHEET

Model Home Construction

The model homes can be constructed using sytrofoam panels available as insulation in a lumber yard. They are, generally, approximately 24cm x 120 cm. One model house is easily constructed out of a single panel this size, ending up 20cm deep by 40cm wide by 30cm high. The styrofoam is easily cut with a razor blade and glued together with a thick white glue. The white glue seals up openings in the seams as well as holds it together. Windows can be made of clear plastic glued to the inside of the model with the same glue. The use of styrofoam provides insulation as well as an easily handled construction material. The roof, also made of styrofoam, is 40cm x 30cm and made to fit on top and also overhang. The size of the window is approximately 10cm x 10cm. The location of the half-window can be marked on the house at the time of construction.

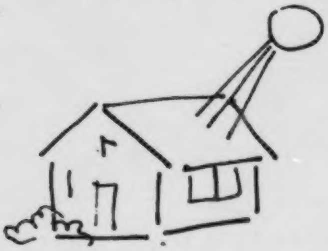
The model houses could be made of virtually any insulating material (wood, cardboard, newspaper, etc.). The window could be made of polyethylene or kitchen wrap type of plastic film. Glass should not be used becuase of its weight and the chance of breakage.

When light passes into a house and strikes any surface, the visible radiation is absorbed and infrared is re-radiated. This longer wavelength radiation is associated with heat. The glass allows light in but doesn't allow the heat out. This is referred to as the "greenhouse effect". A darker surface absorbs better due to greater production of this infrared radiation.

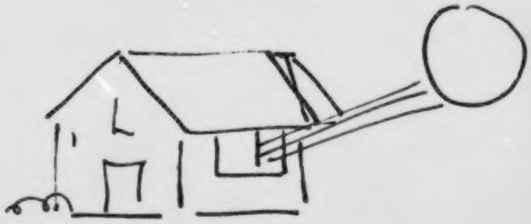


The model house with no shadow on the window will generally go up to 5 - 10 degrees centigrade in the time provided. With a 1/2 shadow, the increase is 3 - 5 degrees centigrade and with the full shadow, there is generally no increase.

The optimum overhang for a house will vary with latitude, position of the window, etc.



Summer at noon



Winter at noon

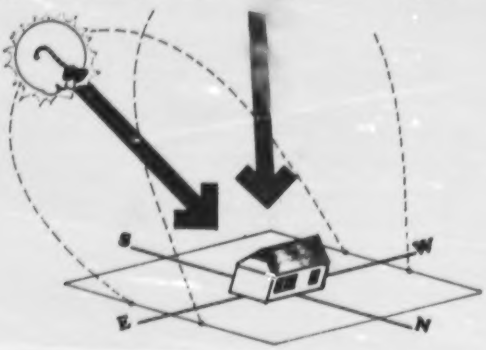
During the summer where the sun is at a higher angle, the overhang should be far enough out so that the window is covered completely. In the winter with a smaller angle, the sun has a greater chance of entering the same window.

Student Worksheet

SITE ORIENTATION

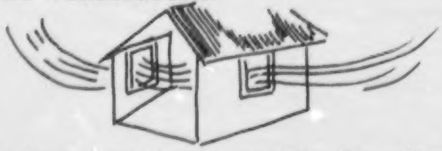
To conserve energy, maximum use should be made of natural means to produce a healthful and livable home environment with minimum use of mechanical equipment for climate control. A primary consideration is the site-the place where the home is to be built or where it already stands. The site features may be positive or negative factors in terms of energy requirements and are always unique. The major factors of climate and vegetation determine the proper orientation (position with relation to the compass) of the home's features as well as the landscaping which might reduce mechanical heating and cooling costs. General orientation considerations include:

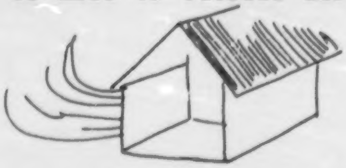
1. The building should be oriented to maximize exposure to solar radiation during the heating season; and minimize exposure during the cooling season.



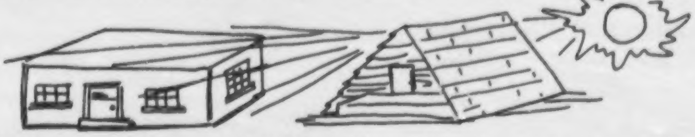
Sun Angles for Winter and Summer

2. The relationship of the building to outdoor spaces should be designed to maximize, within limits, air movement in hot weather, and minimize air movement in cold weather. Use should be made of outside air motion for natural ventilation.

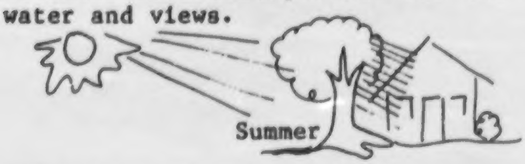


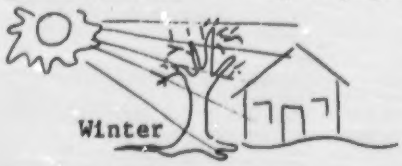


3. Orientation must recognize the effect of nearby buildings and topography.

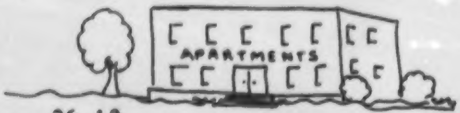


4. Orientation should provide for the advantageous use of trees, topography, water and views.





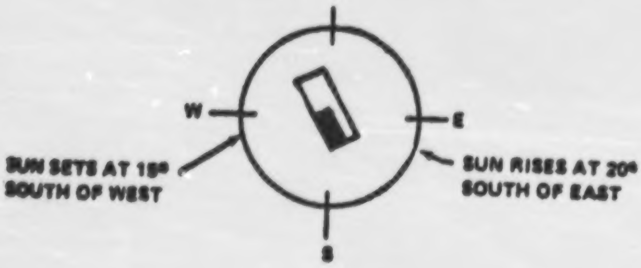
5. Orientation should be suited to the lifestyle of the building occupants.



Student Worksheet

ORIENTATION TO SUN AND WIND

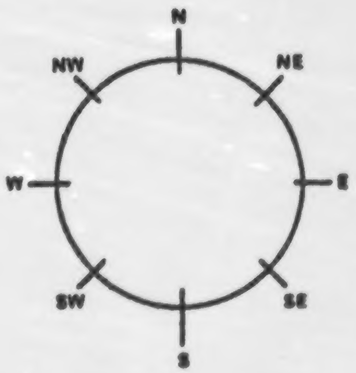
The way in which your home is oriented to the sun and wind affects the impact of the climate and the energy needed to maintain comfort. To understand this concept, it is helpful to determine the compass orientation of your home. First, think of your home as a box (usually a rectangular box) and view it from a bird's perspective. Given the directions of the compass on the circle below, locate your house in the center facing the appropriate direction. Use a compass to determine which direction each side of your home faces. It may not be directly North, South, East or West, but using the face of the compass and this circular representation you should be able to make a good estimation of the direction. Once the house is sketched on the circle, use your compass to locate the point at which the sun rises and sets.



In the example on the left, the house is rectangular and the living area (the family room/kitchen) is represented in black. You can see that the long axis of the house runs slightly West of North by slightly East of South. The points indicating the sunrise direction and sunset are marked. Conclusion: The family room area will receive the afternoon sun and be a "sun warmed" area. This could be beneficial or harmful depending on the climate.

Use the circle on the right to locate your house.

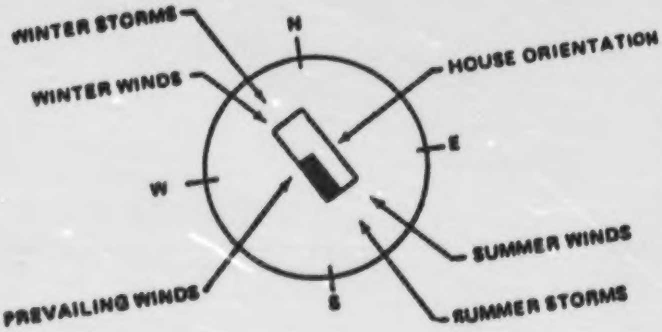
1. Draw in your house's orientation to the compass.
2. Draw in where the sun rises and sets.
3. Where are the living areas (den, family room, kitchen) of your house in relation to the compass?
4. Are the living areas exposed to morning or afternoon sun?



Student Worksheet

ORIENTATION TO SUN AND WIND
(Continued)

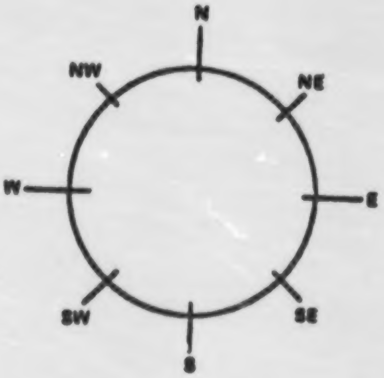
In addition to the sun, the winds also can be located on a similar drawing. Using the same example, we can illustrate the direction from which the winds affect the house. Information about winds can be found through observation or by inquiring at your local weather bureau, agricultural extension service, or news agencies. There may be slight differences within a local area due to hills or water.



In the example, the living area is only exposed to prevailing winds and slightly to summer storm winds. The winter winds are from the Northwest so the example house should not have large window areas on the Northwest side if it is located in a temperate or cool climate zone.

Use the circle on the right to locate your house.

1. Locate house orientation.
2. Locate prevailing winds
3. Locate summer winds and summer storms.
4. Locate winter winds and winter storms.
5. Which areas of your house are exposed to storm winds? To winter winds?



Do you feel your house has a good or poor orientation to the sun and wind? Why?

454

Student Worksheet

BUILD A SOLAR GREEHOUSE

Build a solar greenhouse and a standard greenhouse according to these drawings. (Be sure to cut 2 of each side panel).

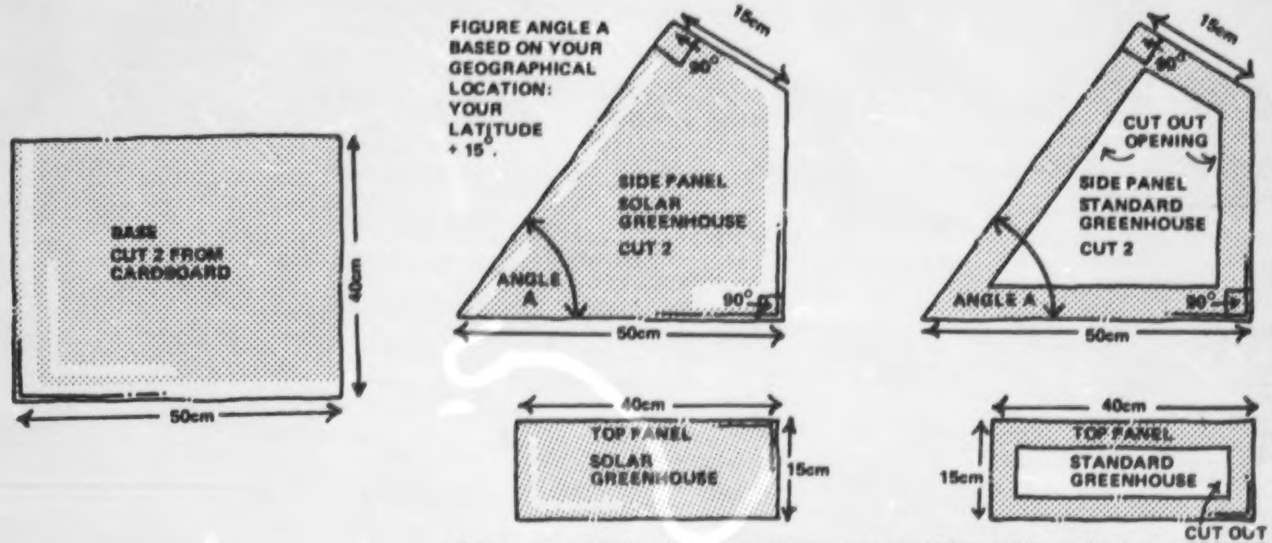
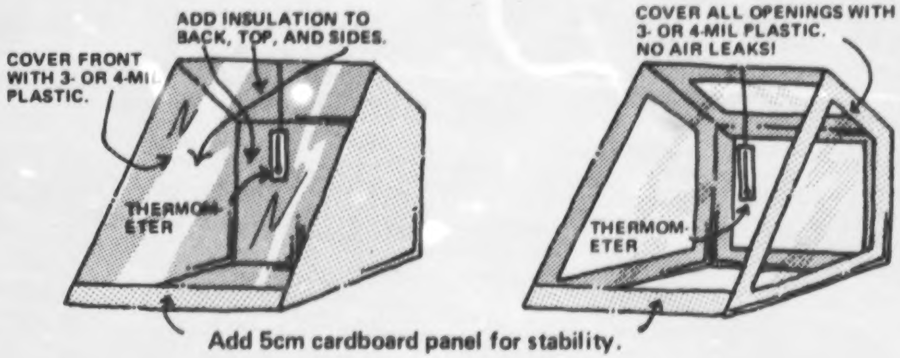


FIGURE ANGLE A BASED ON YOUR GEOGRAPHICAL LOCATION: YOUR LATITUDE + 15°.
BASE
CUT 2 FROM CARDBOARD
40cm
50cm
15cm
90°
SIDE PANEL
SOLAR GREENHOUSE
CUT 2
ANGLE A
90°
50cm
15cm
90°
CUT OUT OPENING
SIDE PANEL
STANDARD GREENHOUSE
CUT 2
ANGLE A
90°
50cm
40cm
TOP PANEL
SOLAR GREENHOUSE
15cm
40cm
TOP PANEL
STANDARD GREENHOUSE
15cm
CUT OUT OPENING

Spray the outside of the greenhouses white before adding plastic.

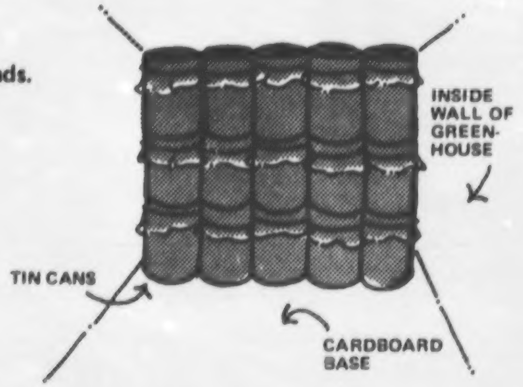

ADD INSULATION TO BACK, TOP, AND SIDES.
COVER FRONT WITH 3- OR 4-MIL PLASTIC.
THERMOMETER
COVER ALL OPENINGS WITH 3- OR 4-MIL PLASTIC. NO AIR LEAKS!
THERMOMETER

Add 5cm cardboard panel for stability.

Spray the cans flat black.

Fill with H_2O and cover tightly with plastic wrap and rubber bands.

Stack them in the back of the solar greenhouse.


INSIDE WALL OF GREENHOUSE
TIN CANS
CARDBOARD BASE

Student Worksheet

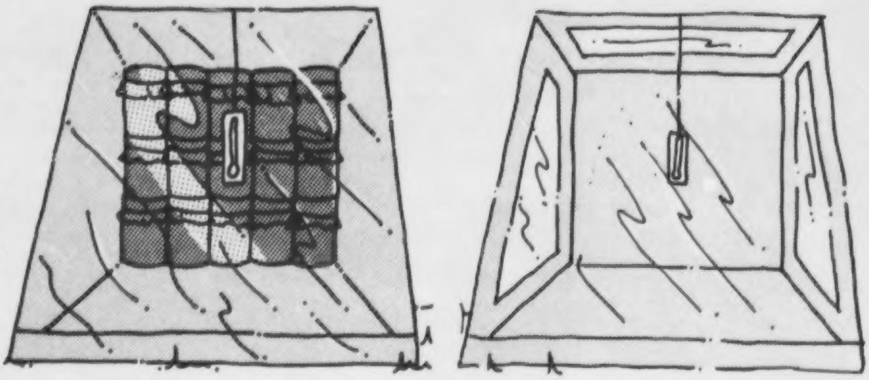
BUILD A SOLAR GREEHOUSE
(Continued)

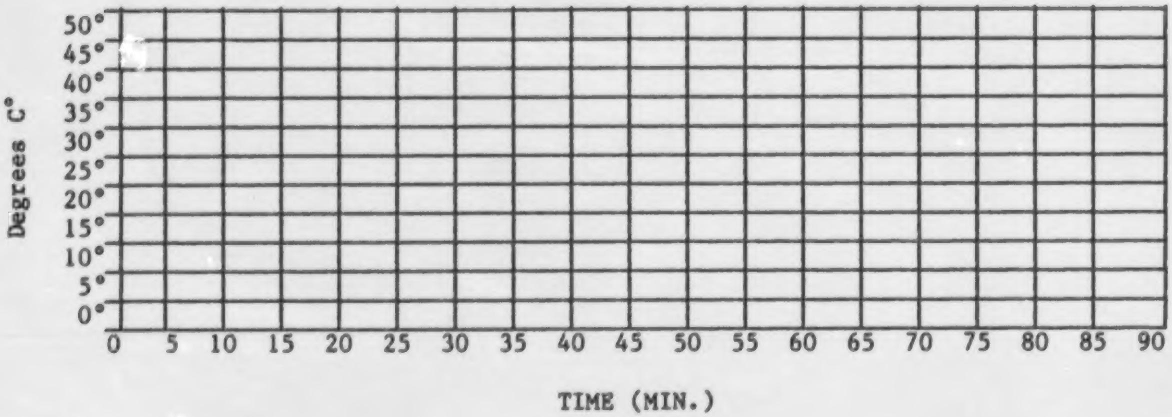
Face both greenhouses directly into the sun.

Measure and record the temperatures in each one as the day progresses.

After they have reached a high temperature place both in the shade - read and record the temperature as they cool off.

Graph the results of your experiment.





Answer the following question and do the following activities:

1. Would you save energy in your climate by using a solar greenhouse?
2. Design a home that would receive all or part of its heat energy from a solar greenhouse.
3. Illustrate how you would fit your present home with a solar greenhouse.
4. Design a business based on one or a series of solar greenhouses.
5. Research and report on any areas in Arkansas where solar greenhouses are in use for heating, pleasure or business.

Source: United States Department of Energy

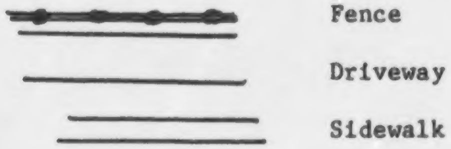
Student Worksheet

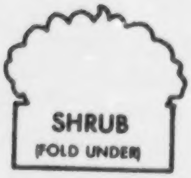
CONSTRUCT A MODEL DWELLING

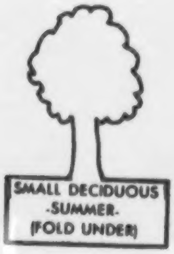
1. Cut and fold the model dwellings on Student Worksheet 36.19; assemble without taping.

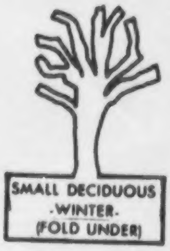
2. Design a lot where either model dwelling will be erected. Taking the physical characteristics of this lot into consideration, make decisions about room, window and door placement in the dwellings. Unfold the dwellings and draw in the windows and doors.

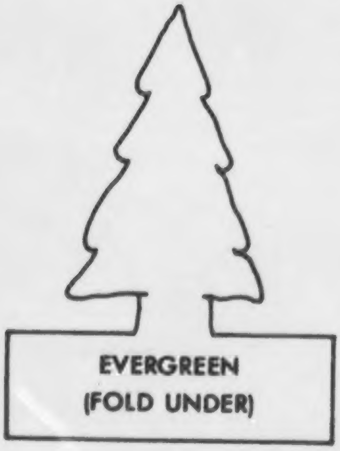
3. Refold and tape the model dwellings. Place one of the taped model dwellings on its lot. Landscape the lot, using plants below, to take advantage of the shade they offer in the summer and openness in the winter. Repeat with the other model dwelling.

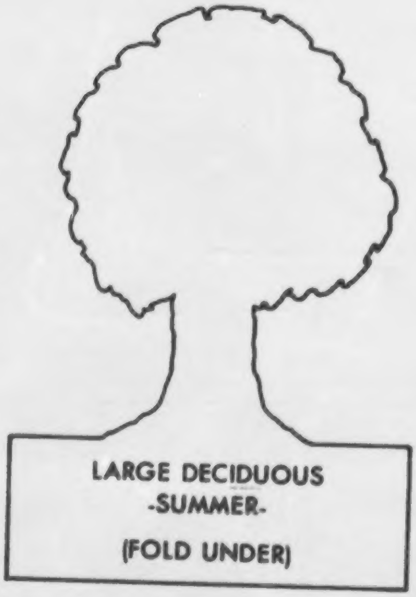

Fence
Driveway
Sidewalk

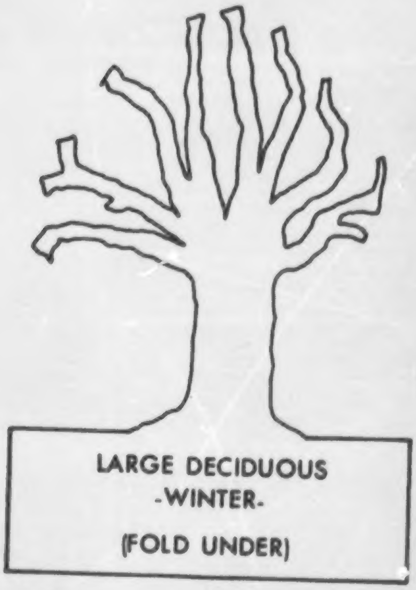

SHRUB
(FOLD UNDER)


SMALL DECIDUOUS
-SUMMER-
(FOLD UNDER)


SMALL DECIDUOUS
-WINTER-
(FOLD UNDER)

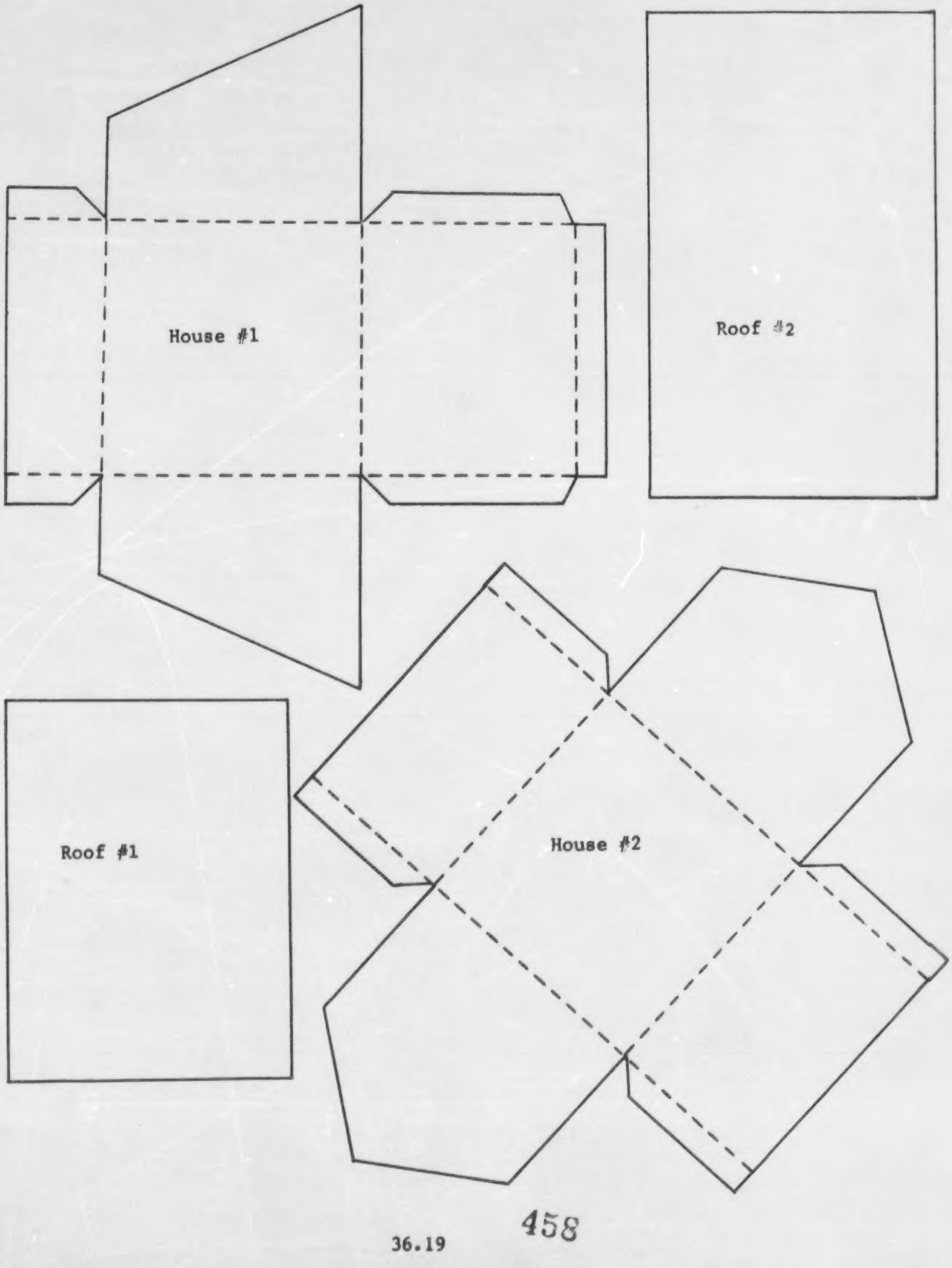

EVERGREEN
(FOLD UNDER)


LARGE DECIDUOUS
-SUMMER-
(FOLD UNDER)


LARGE DECIDUOUS
-WINTER-
(FOLD UNDER)

Source: United State Department of Energy

Student Worksheet


House #1
Roof #2
Roof #1
House #2

LESSON #37

CATEGORY: Conversions

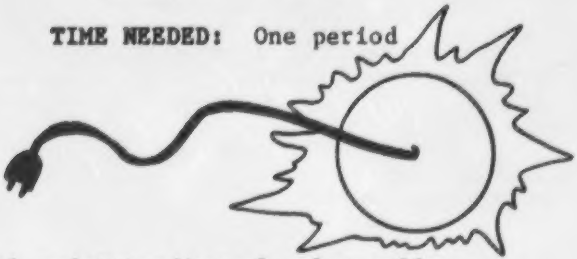
ENERGY TYPE: Direct Solar

TITLE: Solar Cells

GRADE LEVEL: 8-10

INFUSE WITH SUBJECT AREA:
Science

TIME NEEDED: One period



MATERIALS:
None

OBJECTIVES:

1. The students will gain a general understanding of solar cells.
2. The students will discover the relationship between the sun's energy and its use for generating electricity.

TASK ANALYSIS:

The students should be able to read material and answer questions about that material.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets and Background Information 37.3 - 37.6.

2. Steps in Lesson
   Objective #1: The students will gain a general understanding of solar cells.

   a. Hand out Student Background Information 37.3 - 37.5 Have the students read the information, then discuss in class.
   b. Hand out Student Worksheet 37.6. Have the students answer the questions individually, then discuss in class.

   Objective #2: The students will discover the relationship between the sun's energy and its use for generating electricity.

   a. Without the development of solar cells for power, the space vehicles and satellites could not have been operated. What are solar cells? (Thin slices - wafers of silicon, about 1-1/2 inches square and only a few thousandths of an inch thick).
   b. Solar cells are called "photovoltaic cells". What does photovoltaic mean? (Photo - light; voltaic = electricity; named after Alessandro Volta).
   c. How does a solar cell produce electricity? (The silicon wafer is coated with boron to produce a positive electric layer; this interacts with the negatively-charged silicon. When photons in sunlight strike the silicon cell, they are converted to electrons which flow to the boron layer, causing a flow of direct current (electricity).
   d. Why are solar cells so expensive? (Skilled hand labor is needed in growing and cutting silicon crystals; more energy used to manufacture cells than they can produce).

e. Ask: "Is there any hope for solar cells for use in power plants?" (Mass production of wafers from ribbons of silicon slices made in a machine looks promising).

f. Investigate possible development of solar power plants on earth. (Most sources agree that the use of solar power plants using solar cells is not likely to provide much of our energy demand for the next 10-20 years or longer. Solar cells used in such a plant would need to be very large.)

g. Ask: "Why would a solar cell power plant be more efficient in space?" (Could be positioned to receive sun's rays 24 hours a day; no loss of solar radiation by reflection and absorption of atmosphere.

3. Evaluation

Check answers to Student Worksheet 37.6.
Use oral evaluation of student understanding during class discussion.

4. Follow-Up Activities

Order Solar Cell Manual and build apparata for class experiments.
Solar Cell Manual by Clyde Wagner
Solar Electric Engineering, Inc.
Glendale, California 91209

STUDENT BACKGROUND INFORMATION

Sources:

Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

Clyde Wagner. Solar Cell Manual. Solar Electric Engineering, Inc.: Glendale, California. 1979.

Solar radiation can be converted directly to electricity. When sunlight falls on certain sensitive materials, it produces a flow of electrons, or an electric current. This is accomplished routinely in the light meters built into camera equipment. The device which accomplishes this magic-like conversion, the solar cell (also known as the photovoltaic cell), was developed in the 1950's at Bell Laboratories. The first strong commerical impetus came from the space program and much of the electronic equipment on the space vehicles is powered by solar cells. Virtually any power output can be supplied by combining the solar cells into panels, forming a "solar array."

Solar cells are now expensive, and their use is therefore limited. The United States Department of Energy is supporting development of solar cells that can be produced inexpensively, and that can be used on utility networks or on individual buildings. Presently, the cost of producing solar cells is about $11 per watt, a dramatic drop from the mid-1970's price tag of $50 per watt, but quite a way from a mid-1980's goal of 50¢ per watt.

A solar cell industry is already in existence in the United States. The space industry has been the major customer, but not the only one. Solar arrays have been fabricated for a wide variety of applications where power requirements are relatively modest and locations are remote. Examples include remote United States Forest Service communications facilities, and aboard private and commercial boats to charge batteries and power communication systems.

Silicon is receiving primary emphasis as a solar cell material in studies supported by the United States Deparmtent of Energy. Silicon is the earth's second most abundant element and is a constituent of common sand. Its technology is highly advanced because of its use in the space program and in the electronics industry (it is the material from which transistors are manufactured). A typical solar cell contains two microscopically-thin layers of silicon with an outside wire attached. In one layer, a few atoms in the silicon crystal have been replaced by boron atoms; in the other, the replacement atoms are phosphorus. Sunlight falling on the cell forces electrons to move along the wire from the phosphorus-silicon layer to the boron-silicon layer. Theoretically, a silicon solar cell should be able to convert about 25 percent of the solar energy into electricity. In practice, 14 percent is the highest conversion achieved so far in mass-produced solar cells.

Solar cells are expensive because their fabrication is largely a handcrafting process. A single crystal of pure silicon is artifically grown in the form of an ingot. Wafers cut from the ingot are polished and trimmed, and the impurities are diffused into the silicon in an oven. Electrical connections are added, and the finished cells are mounted in arrays. Some improvements have already been made in manufacturing methods and quality control, and the outlook appears favorable for further progress.

Solar cells will have a generally benign direct environmental impact. A problem will be the large amounts of land needed for the solar arrays, but some of the arrays can be mounted on roof tops. This not only will save land, but will offer the possibility of reducing the need for transmission lines, an economic and aesthetic benefit. There will be a significant indirect environmental impact. The energy to process the millions of solar cells will inevitably add to the environmental burden.

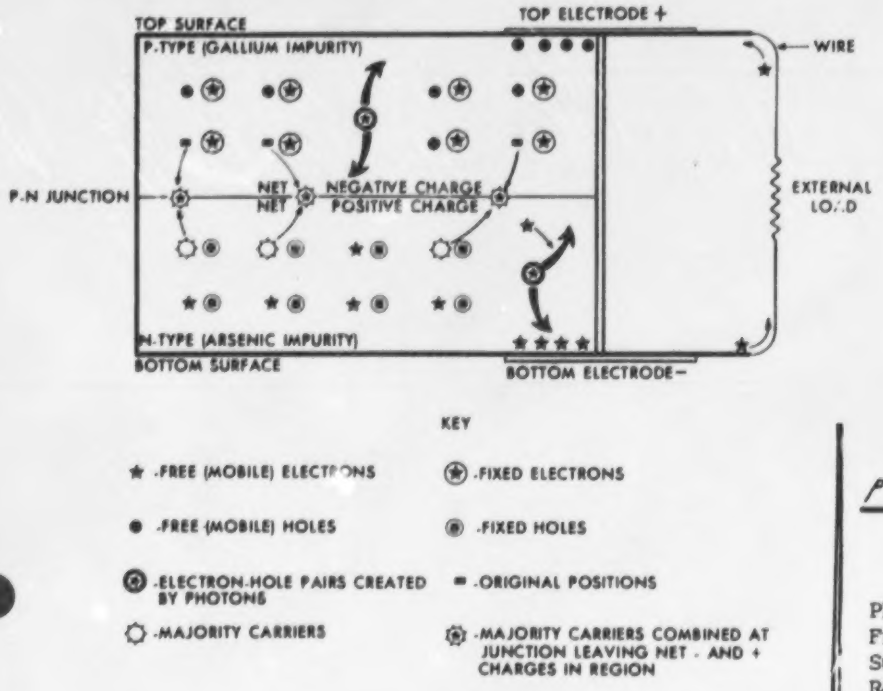
The Mississippi County Community College at Blytheville is an important component in the United States Department of Energy's solar cell development program. The college's physical plant represents a large scale experiment in the application of solar cells. Completely solarized, receiving its heating and cooling via concentrating collectors and its electricity via 60,000 solar cells, it is one of the largest solar cell projects in the world.

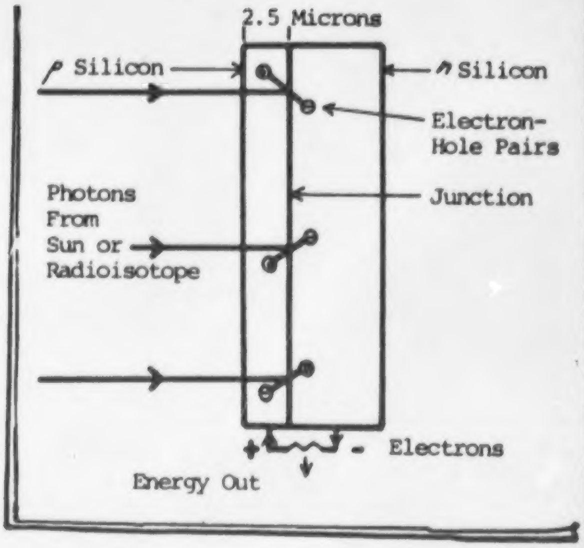
CHARACTERISTICS AND FEATURES OF SOLAR CELLS

1. Silicon solar cells are very fragile and must be handled with care.
2. The output of silicon cells is many times higher than that of selenium cells of the same size.
3. Silicon cells generate their own electricity directly from sunlight; they do not need any other power source.
4. Silicon cells are very stable and do not lose their output with aging.
5. Solar cells will generate electricity when placed under a 150-watt flood light the same as if illuminated by sunlight.
6. Silicon cells will function under a wide range of temperatures from 60 degrees Centigrade to 95 degrees Centigrade (80 degrees Fahrenheit to 200 degrees Fahrenheit).
7. Solar cells generate direct current (DC) only.
8. The power of solar cells or panels can be determined by multiplying the voltage times the current. The answer would be in milliwatts with 1,000 mw. equaling one watt.
9. Silicon cells can supply most electrical needs by solar modules combined into solar arrays.
10. For normal testing of solar cells the temperature should be 28 degrees Centigrade (82 degrees Fahrenheit).
11. Solar cells are connected in series for building up the voltage.
12. Solar cells are connected in parallel for increasing amperes.
13. All solar cells must be tested before placing in a solar module, because one weak cell will degrade the module.
14. Solar panels are capable of powering large electric motors and charging batteries.

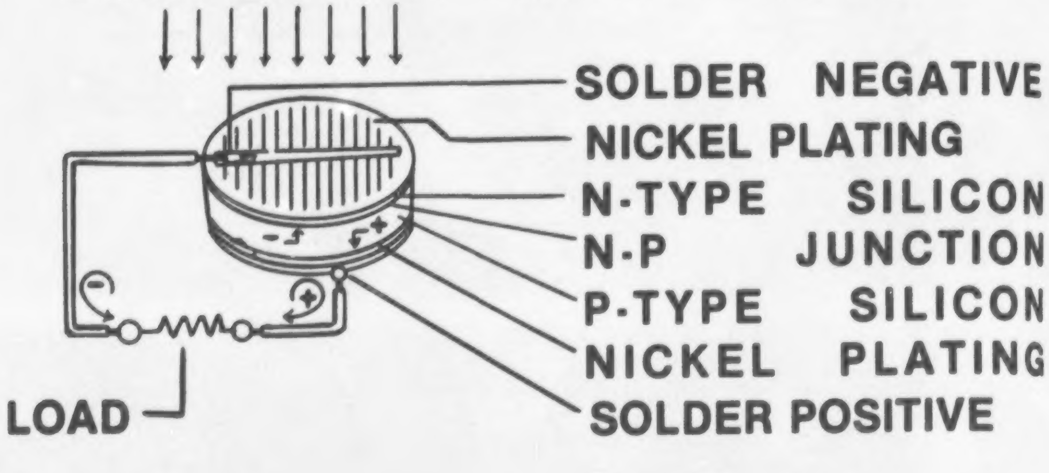
Student Worksheet

SILICON SOLAR CELL


TOP SURFACE
TOP ELECTRODE +
P-TYPE (GALLIUM IMPURITY)
WIRE
P-N JUNCTION
NET
NET
NEGATIVE CHARGE
POSITIVE CHARGE
EXTERNAL LOAD
N-TYPE (ARSENIC IMPURITY)
BOTTOM SURFACE
BOTTOM ELECTRODE−
KEY
★ -FREE (MOBILE) ELECTRONS
-FIXED ELECTRONS
● -FREE (MOBILE) HOLES
-FIXED HOLES
-ELECTRON-HOLE PAIRS CREATED BY PHOTONS
▬ -ORIGINAL POSITIONS
-MAJORITY CARRIERS
-MAJORITY CARRIERS COMBINED AT JUNCTION LEAVING NET - AND + CHARGES IN REGION


2.5 Microns
p Silicon
n Silicon
Electron-Hole Pairs
Junction
Photons From Sun or Radioisotope
+
-
Electrons
Energy Out

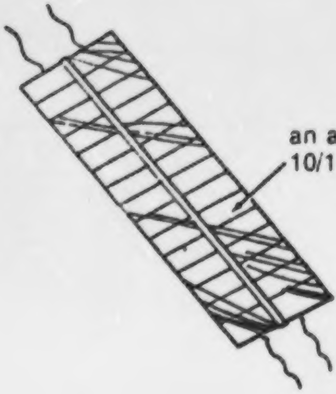
LIGHT ENERGY TYPICAL SOLAR CELL


SOLDER NEGATIVE
NICKEL PLATING
N-TYPE SILICON
N-P JUNCTION
P-TYPE SILICON
NICKEL PLATING
SOLDER POSITIVE
LOAD

Student Worksheet

ELECTRICITY FROM THE SUN

SOLAR CELL



This device converts sunlight directly into electricity, with no moving parts and no pollution.

an array of thin silicon cells 10/1000 in. thick

wires lead to electrical batteries which power lights and motor-driven appliances.

1. Solar cell systems are now used to power spaceships and ____________________

2. We probably will never run out of silicon as a resource because it is the second most plentiful substance on earth. What is its common name? __________

3. If it now costs $20 a watt to generate electricity by means of solar cells, how much would you have to spend on equipment to power just the 100 watt light bulbs in your house? ____________________

4. What do we need to do before we can use solar cells as an energy source? ____

5. How can electricity be stored to use later? ____

ADVANTAGES AND DISADVANTAGES OF PHOTOVOLTAICS

DISADVANTAGES

1. Expensive to install
2. Requires much space.
3. The sun does not always shine.
4. Would mean modification of housing in many cases.
5. New laws needed concerning structures that might cast shadows.

ADVANTAGES

1. (Can you supply the advantages? What is good about solar cells in regard to each of the following?)

1. Supply:

2. Pollution:

3. Embargoes:

4. Cost:

Source: United States Department of Energy

Student Worksheet

ELECTRICITY FROM THE SUN
ANSWER SHEET

1. Satellites
2. Sand
3. Number of bulbs x 100 x $20
4. Further develop technology and bring down cost
5. In storage batteries

Advantages

1. The sun's energy is almost inexhaustible.
2. Solar energy is clean.
3. No nation can cut off another nation's supply of sunlight.
4. Installations are inexpensive to maintain.

LESSON #38

CATEGORY: Impacts

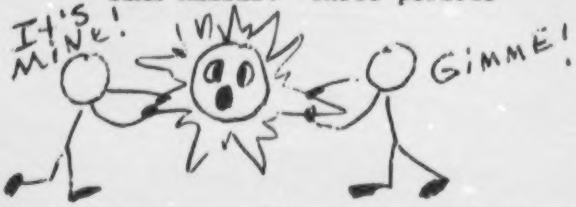
ENERGY TYPE: Direct Solar

TITLE: Sunshine Rights

GRADE LEVEL: 10-12

INFUSE WITH SUBJECT AREA:
Social Studies

TIME NEEDED: Three periods


IT'S MINE!
GIMME!

MATERIALS:
None

OBJECTIVES:

1. The students will recognize some of the social problems involved with the use of direct solar energy.
2. The students will make a value analysis of direct solar energy.
3. (Optional). The students will consider the education of the public on direct solar energy.

TASK ANALYSIS:

The students should be able to express their values; and be able to work in groups to find solutions to problems.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 38.5 - 38.7.
   Read Teacher Background Information (38.3 - 38.4)

2. Steps in Lesson
   Objective #1: The students will recognize some of the social problems involved with the use of direct solar energy.

   a. Have the students brainstorm social problems that occur with the use of direct solar energy. List these on the chalkboard. Share, if you wish, the information found on Teacher Background Information (38.3 - 38.4).
   b. Divide the class into five equal-sized groups. Give each group one of the situations found on Student Worksheet 38.5. Have each group work out a solution for the problem given.
   c. Have each group share its problem and solution with the class. Discuss the results.

   Objective #2: The students will make a value analysis of direct solar energy.

   a. Explain to the students that this lesson uses a value analysis scale to measure the costs and benefits of energy policies. Explain the value analysis scale by using the two examples on Student Worksheet 38.6.
   b. Have students work together in groups of 3 - 5, to complete Student Worksheet 38.7. Tabulate group totals on the chalkboard and have students compare their ratings with the overall class rating.

c. Discuss the following questions:
  - Were there differences of opinion in your group about the analysis? How did you resolve them?
  - Did your group differ from the rest of the class in the rankings?
  - Give examples of negative and positive effects that you gave a high number value. Why were these most important to you? Would these be of the same importance to society as a whole?
  - Would the importance of direct solar energy increase or decrease as a result of your decisions?
  - What are the implications on the economy as a result of your decisions?
  - What would be the social costs or benefits from your decisions?

Objective #3: (Optional). The students will consider the education of the public on direct solar energy.

a. Explain to the class that they are going to set up a program for the purpose of educating the public on the advantages of direct solar energy as a future source of energy.

b. Divide the class up into four equal-sized groups. Assign a different one of the following tasks to each group:
  - Set up an advertising campaign that will get direct solar energy in the public eye.
  - Set up a program of workshops on direct solar energy for teachers and students.
  - Set up a series of training programs for installers, manufacturers and other interested people on direct solar energy.
  - Set up a plan for working closely with existing utilities in the implementation of direct solar energy.

c. Have each group present its plan to the class for discussion. Have the class tie the presentations together to make a comprehensive plan.

3. Evaluation

Have the students actually use their energy plan on a test group of parents, other students or other volunteers. Ask the group for feedback on the success of the plan.

4. Follow-Up Activities

Send copies of the class energy plan to the Arkansas Energy Office.

Set up an interview form and interview the public on their feelings about solar energy.

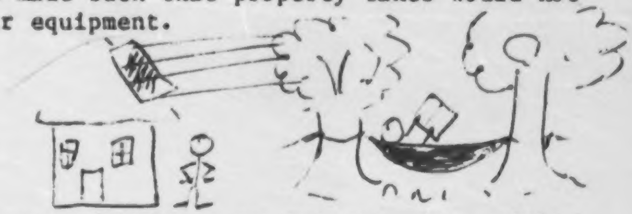
Call Arkansas Energy Office at 800-482-1122 for information on solar energy.

TEACHER BACKGROUND INFORMATION

Source:

Paul L. Butt. Arkansas and Energy: A Look at the Alternatives. Arkansas Ecology Center: Little Rock. 1979.

Based on the experiences of other states, the incentives which seem to stimulate use of direct solar energy are income tax credits, property tax incentives, and incentives given by financial institutions. Some of the financial institutions in the western states have initiated a program to finance solar equipment and attach its cost to the end of an existing mortgage. The payments of the mortgage do not change; only the length of the mortgage increases. A study needs to be made to determine the reasons it was attractive for the financial institutions to offer such programs. This type of financial arrangement in Arkansas could create a positive effect in the promotion of solar. At the present, the income tax incentive in Arkansas is only a deduction (subtracted from gross income) and that does not create as much impetus as a tax credit (subtracted from total income tax owed). The attractiveness of solar systems in Arkansas would increase if policies were made such that property taxes would not be increased by the installation of solar equipment.



Before direct solar energy is widely used, solar rights will have to be established to prevent a neighbor from putting up trees or buildings that block out the sun. The problem of solar rights is simple in nature but very difficult in its solution. Solar energy systems are capital intensive with solar collectors being a significant expenditure. Any tall structure or object can render a solar system useless. Many state legislatures are addressing the issue of solar rights, and Arkansas needs to follow suit. Simply stated, there are 3 approaches being considered by the states:

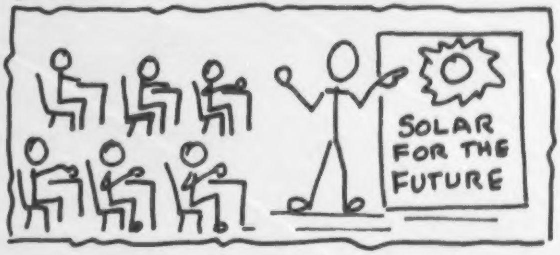
1. Solar zoning: a method whereby local governments are given the authority to zone for the protection of solar rights.

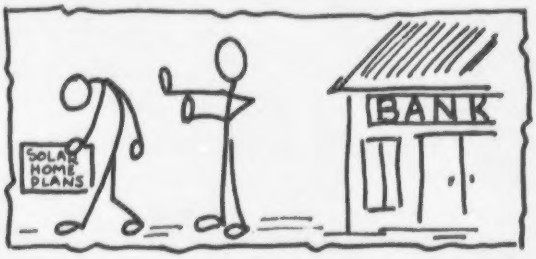
2. Solar easements: A method where two or more parties may enter into a private contractual agreement preserving solar rights.

3. Solar access: A more general statewide, legislative approach guaranteeing solar rights.

There are many barriers that are delaying the widespread use of direct solar energy. Probably most significant are educational barriers due to lack of information or training. There is an insufficient awareness among the public of the uses and possibilities of solar energy, its costs and benefits, its simplicity, and the fact that it is ready and available now. There are not enough training programs for installers, manufacturers, and other professionals.

Economic barriers probably rank a close second behind education. The federal budget for research and development of direct solar energy increased more than fourfold between 1975 and 1979, but in 1979 the federal government spent only about 6 percent of its total energy budget for this purpose, a disproportionate amount compared with solar's potential contribution. Economic impediments also include a shortage of capital for solar buyers; many financial institutions are governed by regulations which prohibit them from making solar loans or insuring mortgages to solar home buyers. Insurance for a solar home is often as difficult to obtain as a loan. And the solar market is still too small, which results in inadequate capital to allow for mass producing and lowered prices.





There are marketing barriers, including problems with standards and consumer protection. There are legal barriers due to lack of legislation in the areas of solar incentives and solar rights. The utilities often represent a barrier to solarization. Because the fuel for solar energy is free, it is not surprising that the utilities and other conventional energy companies are not enthusiastic about supporting an approach that would only sell furnaces, not fuel. The conventional energy establishments are largely responsible for much of the adverse solar publicity that is available.

Solar fuel is free!
Environmentally safe!
Inexhaustible source!
Found everywhere!
Low maintenance!
Simple technology!

Expensive to install!
No loans available!
Not enough tax credits!
Varies with weather & climate!
Storage problems!
High insurance rates!

Direct solar energy is one of the most attractive alternative energy sources in Arkansas's future. Utilization of direct solar energy results in minimal harm to the environment, and the amount of energy available for conversion is several orders of magnitude greater than all the present energy requirements. Due to the existing educational, economic, and other barriers, solar energy will likely make only a small contribution to the state's energy supply by 1985. It could, however, make significant contributions at a local level by 1985, and at the state level after 1985, when oil and natural gas prices have risen and mass acceptance -- and thus, mass production -- have reduced the installation and other initial costs of direct solar systems.

Student Worksheet

SOLAR SITUATIONS

1. The Greens are an average-income family with two children. They have been saving for ten years to build their dream house. They would like to utilize direct solar energy; however, it currently costs as much as $8,000 to $12,000 to equip an average house with a reliable and dependable (25 years life expectancy) active solar energy system. This cost would be in addition to existing construction costs since a back-up heating system would also be necessary. Solar heating can be expected to supply 70-80% of the heating needs of an average house on a cost-effective basis. The Greens are reluctant to pay this additional cost, on top of already high construction costs, in order to achieve a reduced monthly utility expense. In addition, the relatively low electric and natural gas rates in Arkansas cast doubts on the ability of the system to pay for itself in a reasonable time period.
   What are your suggestions for the Greens?

2. The Browns have wanted to build a home with passive solar features for several years, because of their interest in ecology and being "independent" of power utilities. But when they went to a financial institution for a low-interest loan, officials there told them that the agency had no passive solar designs to recommend. The agency had never financed such a house in Arkansas.
   What are your suggestions for the Browns?

3. The Black family has completed plans for an earth-shelter house that will also utilize passive solar techniques. Construction was about to begin, when they were served with a restraining order instituted by their prospective neighbors. According to the zoning board an earth-sheltered home would constitute an incompatible use of land due to its size and location. It would not preserve the character of the neighborhood.
   What are your suggestions for the Black family?

4. When Mr. Gray built his home, he included a mass of windows along the south side and solar panels on the roof. To assure continued solar access he obtained an easement from adjoining neighbors to guarantee that they would not block the sun with future construction or landscaping. Recently one of the neighbors died leaving his property to relatives in a distant state. These relatives have moved to Arkansas and begun construction of a large three-story house that will block Mr. Gray's southern exposure. When he protested their actions he was told that the agreement was made with the previous owner and was no longer binding.
   What are your suggestions for Mr. Gray?

5. Built two years ago, the home of the White family receives direct-gain heating and additional living space from a central two-story greenhouse. The structure itself serves as the storage medium, with air drawn in through underground ducts, cooled by the earth and circulated through spaces in the north and south walls. The warm air is exhausted through a cupola atop the greenhouse. Today the White home is in danger due to structural weaknesses in the greenhouse, that resulted from use of substandard building materials. The Whites have learned that Arkansas has not adopted specific building codes for solar homes. The conformance of buildings to the existing codes really depends on the interpretation of a local official.
   What are your suggestions for the White family.

Student Worksheet

VALUE ANALYSIS SCALE

EXAMPLE I - Sample

ENERGY-RELATED DECISION

Should a law be passed prohibiting people from driving cars that are not tuned up (do not burn gas efficiently)?

-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +10

List and assign negative effect values		List and assign positive effect values	
1. Impossible to enforce	-10	1. Saves gasoline	+ 2
2. Most people will not do it	- 8	2. Less air pollution	+ 6
3. Police would spend too much time trying to enforce	-10	3. Increase work for service stations	+ 3
4. Would hurt low income people	- 3		
5. Would not save much gasoline	- 2		
Total	-33	Total	+11

EXAMPLE 2 - Sample

ENERGY-RELATED DECISION

Should people who get regular tune-ups for their cars be given a tax deduction for their expense?

-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +10

List and assign negative effect values		List and assign positive effect values	
1. It would be difficult to determine the tune-ups were really done	- 8	1. It would save gas	+10
2. It encourages people to be dependent upon cars	- 2	2. It would save personal taxes	+ 8
3. It reduces government revenues and adds to its debt	- 2	3. Less air pollution	+ 8
4. Regular tune-ups are not an important way to deal with energy conservation	- 8	4. It would encourage car repair sales and jobs	+ 5
Total	-20	Total	+31

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Student Worksheet

VALUE ANALYSIS SCALE
(Continued)

Four energy policies

1. Arkansas should have no involvement in standards of solar equipment or building codes.
2. Arkansas should have legislated legal rights to guarantee sunshine accessibility to solar buildings.
3. The state government should levy taxes to subsidize development and use of solar energy.
4. There should be increased taxation due to higher assessed value of solar structures.

Value Analysis Scale

Energy-Related Decision ____________________

____

____

____

-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +10

TOTAL ________

TOTAL ________

LESSON #39

CATEGORY: Impacts

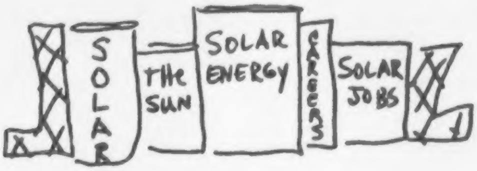
ENERGY TYPE: Direct Solar

TITLE: Your Future in Solar Energy

GRADE LEVEL: 9-12

INFUSE WITH SUBJECT AREA:
Career Education
Reading

TIME NEEDED: Two periods



MATERIALS:
Library resources

OBJECTIVES:

1. The students will use available school and community libraries to find new information on solar energy.
2. The students will examine careers in solar energy.

TASK ANALYSIS:

The students should be able to do independent research using library resources.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 39.4 - 39.7.
   Read Teacher Background Information (39.2 - 39.3)
   Arrange for use of the library.
   Arrange for speakers.

1. Steps in Lesson
   Objective #1: The students will use available school and community libraries to find new information on solar energy.
   a. Hand out Student Worksheets 39.4 - 39.5 Discuss the sheets in class. Have the students do the activities in small groups or individually.

   Objective #2: The students will examine careers in solar energy.
   a. Announce to the students that they will assemble a notebook on solar energy careers.
   b. Hand out Student Worksheets 39.6 - 39.7. Discuss individually or in small groups.

3. Evaluation

   Check notebooks prepared by students.
   Check answers to student questions.

4. Follow-Up Activities

   Have the school guidance counselor address the class on opportunities in solar energy.
   Have speakers visit the class from various businesses with solar connections.

TEACHER BACKGROUND INFORMATION

CAREERS IN SOLAR ENERGY

Source:

United States Department of Energy. *Solar Energy Project*. Washington, D.C. 1979.

Career education is striving to provide an active relationship between the academic world and the world in which people earn a living. Most high school students do not have adequate knowledge of the career opportunities open to them, especially when there are tens of thousands of job titles in the United States, and especially when the number of these job titles increases almost too rapidly to keep track of them. Consideration of the job opportunities in a new and rapidly expanding field, such as solar technology, should help to bridge the gap.

The United States Department of Education has developed the cluster concept, which groups job titles in the following categories:

- Construction
- Manufacturing
- Agribusiness and Natural Resources
- Marine Science
- Environment
- Business and Office
- Consumer and Homemaking
- Marketing and Distribution
- Communications and Media
- Hospitality and Recreation
- Personal Service
- Health Opportunities
- Fine Arts and Humanities

Some of the jobs and careers in solar energy which students will "discover" are listed below:

- Insulation Installer
- Auxiliary System Installer
- Sheet Metal Worker
- Fabrication Worker
- Prefabrication Worker
- Architect
- Lawyer
- Salesperson
- Real Estate Broker
- Appraisor
- Assessor
- Zoning Agent
- Consumer Protection Agent
- Home Construction Laborer
- Standards Developer
- Scientist
- Insurance Agent
- Investor
- System Installer
- Dealers
- Builders
- Maintenance Person
- Repair Person
- Bill Collector
- Inspector
- Carpenter
- Mason
- Electrician
- Plumber
- Air Conditioning Person
- Heating Person
- Cooling Person
- Refrigeration Person
- Glazier
- Factory Worker
- Crane Operator
- Roofer
- Pipe Fitter
- Contractor
- Legislator
- Consultant
- Engineer
- Designer
- Developer
- Banker
- Estimator
- Researcher
- Furnace Person
- Trainer-Educator
- Licenser

Following is a list of references students might find useful:

1. United States Department of Energy. Careers in Energy Industries. Washington D.C. 20000. Pamphlet-FEA/A-75/228.

2. Megatech Corporation. Energy Sources and Careers. Billerica, Massachusetts 01821. Booklet/transparencies. 1978.

3. Science Research Associates, Incorporated. School Subjects and Jobs. Chicago, Illinois 60607. 1971.

4. Work Life, August 1976. "Solar Energy: Potential Powerhouse for Jobs." (Reprinted in Social Issues Resources Series, Energy, Volume 2-#33).

5. The Chamber of Commerce of the United States. Nation's Business, The Dawn of an Industry, September 1974. (Reprinted in Social Issues Resources Series, Energy, Volume 1-#79).

This nation is facing an energy crisis. The costs of energy sources are continuously rising as their supply is decreasing. The natural gas shortage in the winter of 1977 led many people to realize that we must begin to search for alternate energy sources. One of these sources is solar energy.

It is very important that all citizens be made aware of all the possible energy sources. This education can begin in the schools. Therefore, students should make optimum use of the library facilities in order to determine what alternatives we have in the energy field, especially in solar energy. Since most information on solar energy is of a recent nature, students should be directed to make particular use of magazine articles and pamphlets.

Student Worksheet

SOLAR ENERGY RESEARCH

METHOD

1. From The Reader's Guide to Periodical Literature or other library references, find and list the articles or books concerning the energy crisis, sources of energy, and solar energy. Use one or more of the data sheets to record this information.

2. Using your list, find as many of these articles as possible. Read five of them and note the important parts on a separate sheet of paper. While doing this keep in mind that the material could be used for general discussion by all the class. If a source is not available, also note this on your data sheet.

The information you have collected will serve as a reference to you, your class and your teacher in studying solar energy. It will also serve as a bibliography for your own research of solar energy. The sources which you could list, yet not find in your library, may be available in other libraries such as county, regional or even state libraries.

QUESTIONS

1. Which magazine or reference do you think contains the best article on solar energy.

2. Based on your research, how important is solar energy as a future energy source?

GOING FURTHER

1. Write a research paper on some aspect of solar energy.

2. Try to obtain additional information on solar energy from such sources as: government agencies, utilities, industries or businesses.

3. Try to obtain some of the sources not available in your library.

Source: United States Department of Energy

Student Worksheet

LIBRARY RESOURCE LIST DATA SHEET

Title of the Article or Reference	Author, if Indicated	Magazine or Other References	Volume Or Issue	Date	Pages	Where Available	Readibility of Article

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Student Worksheet

SOLAR ENERGY JOBS AND CAREERS

1. Discuss the concept of "career education" with your teacher and other class members. Define the term.

2. Using The Reader's Guide to Periodical Literature, and recent magazines and news articles, conduct a literature search for articles and information on solar energy jobs and careers. Also use your career guidance library to obtain additional career information on this topic. Keep a "jobs and careers" notebook containing the information you have obtained, along with any articles or information which you were able to find.

3. Search the employment sections of various newspapers for advertisements relating to solar energy jobs and careers. If possible, cut these out and place them in your notebook.

4. Using the results of your literature search and the employment ads you found, develop a list in your notebook of jobs and careers in the solar energy field. For each, determine what the job is, and what education levels and skills are required. Both the ad itself and your career guidance library will be helpful for this.

5. Listed below are some of the processes used in the solar energy industry. Working in a small group with 2 - 3 other students, define the processes in your notebook. A word glossary may be helpful.

    Collection
    Conversion
    Transfer
    Circulation
    Storage
    Distribution
    Design/construction
    Development
    Expeimentation

6. Listed below are some of the materials and equipment used in the solar energy field. Working with your group again, explain in your notebook what each refers to.

    Collector
    System
    Storage tank
    Pump
    Valves
    Metal ducts
    Piping
    Gauges
    Furnace
    Heat exchanger
    Insulation

7. Working with a partner, arrange to go out and interview someone working in the solar energy industry, such as a businessman or an installer of solar systems. Also interview representatives from state, federal and local agencies who would be knowledgeable about jobs and careers in solar energy. Arrange for some class members to interview the school guidance counselor for information on career possibilities in solar energy.

Source: United States Department of Energy

Student Worksheet

SOLAR ENERGY JOBS AND CAREERS
(Continued)

8. Working in a small group, develop a list of jobs and careers which will be affected by solar energy.

9. Working in a small group, develop a list of solar energy jobs and careers which may be in demand ten to twenty years from now. (This will require some creative thinking.)

By now, you should have a good idea of the job and career possibilities in the field of solar energy. You have found that job and career opportunities are most easily discovered through a search of magazines and newspapers, as well as through direct contact with businessmen, industry representatives and your guidance counselor. Have you found a job or career which might interest you?

QUESTIONS

1. How many different jobs and careers did you list in your notebook?

2. Make a list of solar energy jobs which require each of the following educational levels:
   - -No high school diploma required.
   - -High school diploma.
   - -2 years of college or vocational training.
   - -4 years of college
   - -Advanced degree (Master's or Ph.D.).

3. Where are the best places to look for solar energy job and career opportunities?

4. Are there any new, unusual or interesting job opportunities in solar energy? If so, what are they?

5. Are there any jobs in the field of solar energy located in your immediate area?

GOING FURTHER

1. Make a list of satellite (indirect) jobs which will be affected by the solar energy industry.

2. Keep an updated list over a period of time of new careers and jobs in solar energy.

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LESSON #40

CATEGORY: Impacts

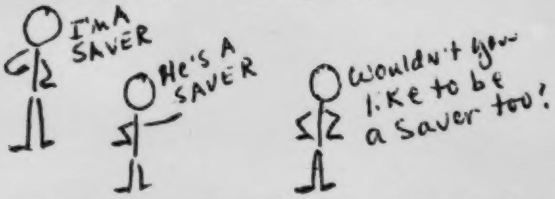
ENERGY TYPE: All

TITLE: Attitudes and Energy

GRADE LEVEL: 9-12

INFUSE WITH SUBJECT AREA:
Social Studies

TIME NEEDED: Three periods


I'M A SAVER
He's A SAVER
Wouldn't you like to be a Saver too!

MATERIALS:
None

OBJECTIVES:

1. The students will recognize that current energy problems involve values.
2. The students will understand the relationship between energy problems and population growth.
3. The students will examine their own attitudes on the use of energy and come to understand the importance of recognizing other people's points of view concerning energy.
4. The students will compare the energy use of the United States with that of other nations, then show a willingness to apply energy-saving values to their own lives.

TASK ANALYSIS:

The students should be able to conduct interviews; be able to read charts and answer questions about the charts.

PROCEDURE:

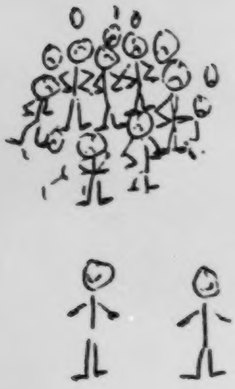
1. Preparation
   Duplicate Student Worksheets 40.6 - 40.11.

2. Steps in Lesson
   Objective #1: The students will recognize that current energy problems involve values.

   a. Ask students to list ways the energy shortage has affected their lives. Make a class list of these changes in life-style. On the basis of the list, discuss which energy shortage or use seems to be the one most closely associated with their lives (Probably gasoline for the family car or high utility bills).
   b. Have students list ways in which per capita energy consumption can be reduced without decreasing the quality of life. In what ways can quality of life be improved by reduced energy consumption?
   c. Hand out Student Worksheet 40.6. Discuss the case studies and answer the questions in class. Encourage students to make up case study situations of their own for class discussion.
   d. Hand out Student Worksheet 40.7. Discuss the sheet and answer the questions in class.

Objective #2: The students will understand the relationship between energy problems and population growth.

a. Hand out Student Worksheet 40.8. Discuss and answer the questions in class.



b. Arrange the students in the class equidistant from one another all over the room. After 3 minutes, discuss their reactions to occupying the space allotted. Then have all of the students move into half the room, and after 3 minutes, discuss reactions. Keep halving the available space until about 2 square feet per student are reached. Discuss the problems of congestion due to overpopulation.
   - List examples of restraints that might result from overpopulation.
   - Discuss how overcrowding can lead to psychological stress.
   - Discuss how stress might lead to competition for the basics of existence, recreational facilities, education facilities, etc.

c. Assume it is decided by our nation that the reproduction rate must be reduced to 50 percent of its present rate in order to assure enough resources to avoid the catastrophes attendant with too large a population for the energy available. Construct a plan within the restrictions of our present social, governmental and legal system to control the number of people.

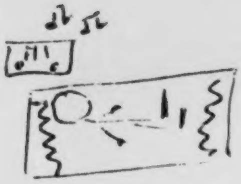
d. (Optional). Interview the head of the school maintenance department. Obtain from him the cost of damage done to the school during the year. In which part of the school was the damage greatest? Does this correlate with the number of people in that area?

Objective #3: The students will examine their own attitudes on the use of energy and come to understand the importance of recognizing other people's points of view concerning energy.

a. Ask the students to make the following chart on a sheet of paper:

Things I Like to do	$	Energy Rank	Father Mother	"10"	Date
1.					
2.					
3.					

- Ask the students to make a list of 5 - 10 things they like to do.
- Place a $ sign by any item which costs more than $3.00 each time they do it.
- Rank from most energy intensive item (1) to least energy intensive item (10).
- Using the code letters "F" and "M", record which of the items on your list you think your father and mother might have had on their lists, if they had been asked to make one at YOUR age.



- -Place a number "10" in front of any item which you think would not be on your list 10 years from now.
- -Review the list and put the date when you last did each item.

Discuss the chart with the students, letting each student who wishes give his responses and the reasons for the responses.

Discuss the following questions:

- -Do all these activities require more than just the energy your body supplies?
- -How many of your activities require that you use energy supplied by the environment?
- -What does your list tell you about your likes?
- -List ways you could conserve energy from your list.
- -Do you think your parents used more or less energy at your age than you do? Why?
- -Is the general pattern of recreational activity in the United States geared to high energy use? If so, what can and/or should be done about it?
- -Of the activities you listed, which ones do you think would not be available to someone in an underdeveloped nation? Why not?

b. Hand out Student Worksheet 40.9. Discuss, then break up into small groups and do the activity.

c. Divide the class up into 5 equal-sized groups. Assign each group to conduct one of the interviews found on Student Worksheets 40.10 - 40.11. Compare the results of the interviews in group discussion, or as group presentations.

Objective #4: The students will compare the energy use of the United State with that of other nations, then show a willingness to apply energy-saving values to their own lives.

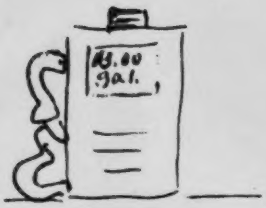
a. As you are probably aware, many other nations are envious of the availablility of natural resources in the United States. Some of these nations are angered by the fact that the United States, with only 5 percent of the global population, consumes approximately 35 percent of the world's resources. Discuss the ethical implications of one social group using (per capita) 25 times as much of an unrenewable resource as another. Keep in mind that the United States is a major exporter of goods to other nations and that significant amounts of energy are consumed in producing the export goods.

b. Calculate how many people the earth could support at the United States' standard of living. (Our 225 million people use nearly 1/3 of the world's energy, so the earth could support 3 times as many people at the United States standard or 675 million).
Compare this with how many people the earth could support at the standard of living of the people of China. (1 billion people use less than 10 percent of the world's energy = over 10 billion).

c. Describe the living conditions of a farm family living in the United States and a farm family living in India; working hours, lighting, education, water source, cooling practices, diet, recreation, transportation, family size, medical and dental care, and relate the energy available to the individual.

Compare death rates and longevity statistics between United States and India in 1900, 1930, 1950, 1970 and 1980.

d. (Optional). Write a research paper comparing the environmental conditions of these 3 high powered, industrialized, technologized nations: Japan, the Soviet Union, and the United States.



e. Review with the class the fact that gasoline sells for $3.00 or more per gallon in many European nations such as Switzerland, Holland, Denmark, France, and Great Britain.

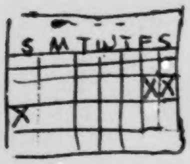
Divide the class into groups of 3 - 4 students. Ask each group to think about and develop a list of ways in which life-styles in those nations with high gasoline costs are likely to be different from the ways people live in the United States, where gasoline is cheaper than in any other highly industrialized nation. Encourage the groups to think broadly beyond such obvious things as size of automobiles and number of superhighways. Types of family vacations, suburban sprawl, status of railroad passenger service, extent of air travel, use of recreational vehicles and many other elements of our life-style can be shown to be related to energy costs.

Ask each group to make value judgements as to whether the life-style in high-energy-costs nations is better or worse than ours. Ask each group to state its conclusion on one or two specific examples and defend its position before the class.

f. Have the students predict the psychological impact on themselves of:

-Unlimited energy use.

-Severely limited energy use.



g. Have the students attempt the following exercise. Tell them to be ready to report on their experiences to the class.

Experience an "energy free weekend". Start Friday at 6:00 PM and end Sunday at 6:00 PM. Live without: electricity, television, radio, range, refrigerator, car, lights, etc. Compare your emotions now and then after you have experienced the weekend.

3. Evaluation

Try a follow-up of the energy free weekend toward the end of the year and compare the reports made by the students of the two.

Have the students look back at their favorite activities listed in Objective #3. Have them review these activities and write down the ones they now feel they could do without or do in another way to conserve energy. Have them list what they would use as a substitute.

Watch for attitude changes and knowledge gain during class discussions.

4. Follow-Up Activities

Simulate a case in front of the "World Court", where a student from an underdeveloped nation sues a student from the United States to obtain his/her share of the world's energy.
Possible roles are:
    Judge
    2 lawyers
    5-person jury
    Defendant (United States student)
    Complaintant and plaintiff (student from underdeveloped nation)
    Witness such as: Representatives from the United Nations; the parents of the students; leaders of the two nations.

Analyze the impact of energy imbalance and use which characterized the contending nations during World War I and World War II.

Describe the characteristics of a primitive agrarian society as related to energy; the characteristics of an industrial society as related to energy.

Give examples of the loss of freedom in our legal system as constraints are placed on energy use.
Describe the relationship of limited energy resources to social systems such as political, economic, and family.

Arrange a bulletin board display. "What would you do?" could be the caption.

Student Worksheet

ENERGY CASE STUDIES

Ms. W. is a traveling salesperson, often traveling over 100 miles a day, sometimes carrying displays. A big car makes this easier, but she worries about low gas mileage. Occasionally, Ms. W. must travel even longer distances. Since there are no trains, she takes a plane. To save money and fuel, the airlines have cut back on flights, meanings Ms. W. often stays overnight. Ms. W's children, ages 9, 11, and 15 travel 1-1/2 miles to school. The youngest child gets bus service. To save money and energy, the school district does not provide bus service for junior or senior high students; therefore, Mr. W usually drives all 3 children to school in the family's second car. The family lives in a large, old home that stays cool in the summer, but is difficult to heat in winter. More insulation would reduce fuel bills, but costs money.

1. List as many examples of energy use in the story as you can.
2. What decisions made by the family influence the amount of energy used?
3. What government decisions influence the amount of energy used by the family?
4. Name one way the family could conserve energy.
5. Besides saving energy, what benefits could they get from this decision?
6. What changes in their life would the family have to make if they were to save energy in this way?

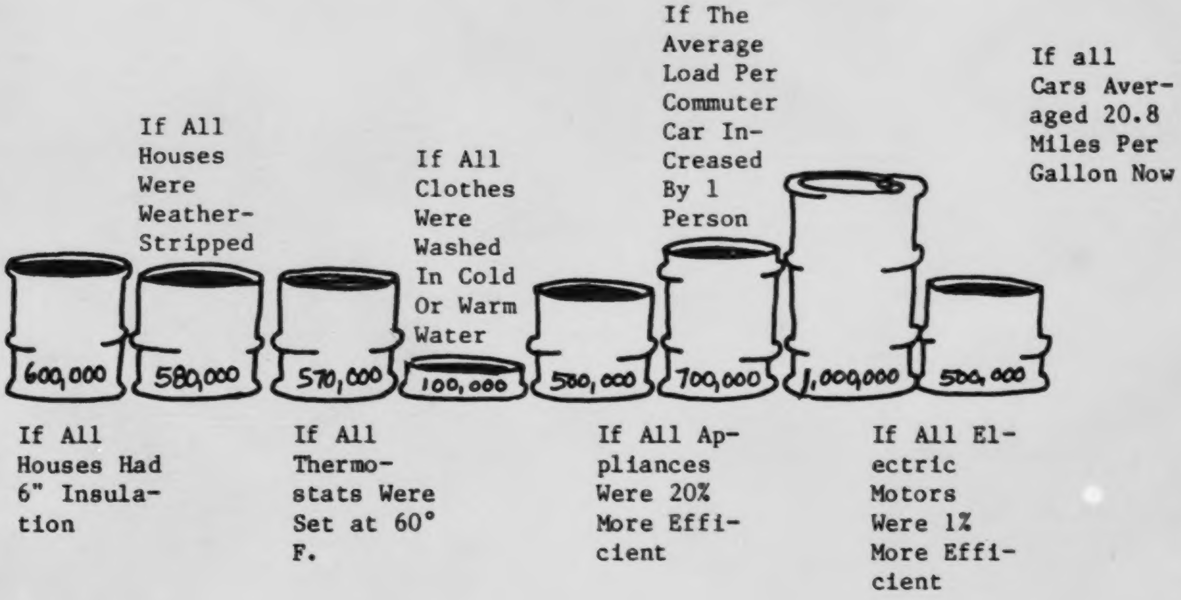
Mr. C. likes living in a big city, but teaches school in a suburb 20 miles from his home. The only train that gets Mr. C. to school on time leaves at 6:15 AM - so he drives his small car to work. The drive to work is easy, on a major highway crossing a toll free bridge, both built by the State and Federal government. After school Mr. C. coaches basketball. This means that he cannot drive to and from work with other teachers who live near him in the city. The students in Mr. C's classes sometimes get angry when he turns the heat down. At Mr. C's apartment, the heat is controlled by the building managers and often gets so hot in the winter that Mr. C. leaves the windows open. Mr. C. has 2 children, ages 12 and 14. Both travel to school in the city by subway.

1. List as many examples of energy use in the story as you can.
2. What decisions made by the family influence the amount of energy used?
3. What government decisions influence the amount of energy used by this family?
4. What decisions made by industry influence the amount of energy used by this family?
5. Name one way the family could conserve energy.
6. Besides saving energy, what benefits would they get from this decision?
7. What changes in their life would the family have to make if they were to save energy in this way.

Write a case study of your own for class discussion.

Student Worksheet

POSSIBLE ENERGY SAVINGS
(in terms of number of barrels of oil saved)



Answer the following questions:

1. Which of these savings require changes in how we live?

2. Which of these savings require changes in technology?

3. Are there any that may require both changes in life-style and technology?

4. If a barrel of oil costs $23, how much money could be saved if:
   a. All homes were insulated?
   b. All appliances were more efficient?
   c. All cars averaged 20.8 miles per gallon?

Some of these savings will require investments. An example of an investment is spending money on insulation now so that fuel bills will be lower later.

5. Name 2 other investments that must be made now so that savings can be made in the future.

Source: United States Department of Energy

Student Worksheet

POSSIBLE ENERGY SAVINGS
ANSWER SHEET

1. insulation
   weather-stripping
   thermostat setting
   washing clothes
   car loads

2. appliance efficiency
   electric motor efficiency
   car mileage

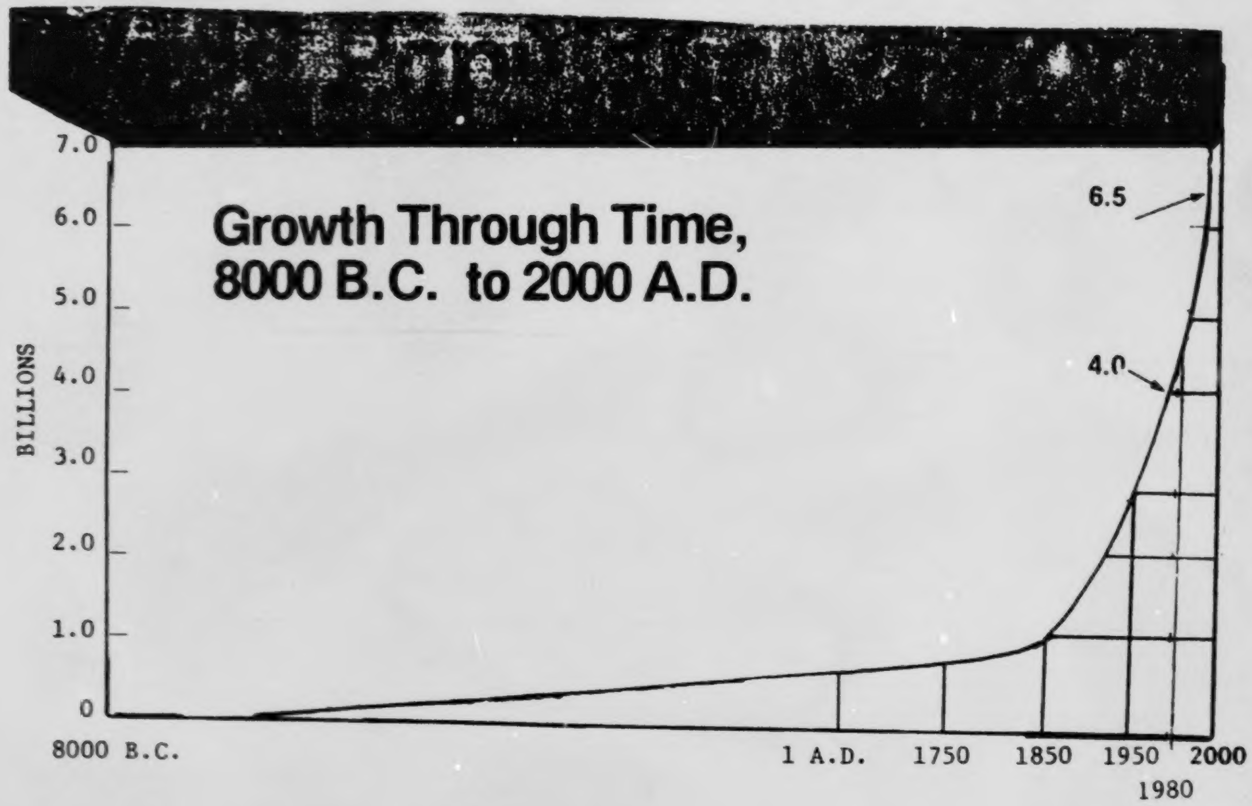
3. car mileage

4. a. $12,800,000
   b. $11,500,000
   c. $11,500,000

5. weather-stripping
   higher mileage car
   energy efficient appliances

Student Worksheet

POPULATION GROWTH



Answer the following questions:

1. What was the world's population in 1980? ____________________

2. When did the world's population reach 1 billion? ____________________

3. How many years did it take the human population to reach a billion? ________ ________; to reach 2 billion? __________ to reach 4 billion? __________.

4. Population growth increases exponentially. What is mean by growing exponentially?

5. What does this exponential growth mean to the quality of life of future generations?

Source: United States Department of Energy

Student Worksheet

POPULATION GROWTH
ANSWER SHEET

1. 4.4 billion

2. 1850

3. unknown (from beginning of man to 1850)
   70 years
   40 years

4. Whenever a quantity grows at a constant annual rate of increase, such as compound interest. A definitive characteristic of exponential growth of a quantity is that it doubles at a constant rate.

5. Less energy per capita for use; an alternative life style

Student Worksheet

IMAGINE YOU'RE SOMEONE ELSE

Divide into groups to role-play the following situations which require reaching decisions based on energy problems.

FAMILY ROLES

Role-play different family members to reach decisions on the following energy problems.

1. Should the family go on a vacation or buy a new fuel-efficient car?
2. Should the child go to camp or buy a 10-speed bike?
3. How can we choose the most energy-efficient appliance when buying a new refrigerator, dish-washer, etc? How do we choose the appliances that are really necessary to us?
4. How can the family conserve energy in the home?
5. How can the family eliminate unnecessary car trips?
6. Other decisions you feel should be added to this list.

COMMUNITY ROLES

Select a possible community problem, such as a gasoline shortage, a rise in electricity rates, a truckers' strike, rationing of heating oil, etc. Problem-solving situations also may be proposed, such as setting up a gas rationing system, eliminating pollution problems, a price-wage freeze, etc.
Select students to play the following roles:

1. Owner of a trucking company
2. A government official
3. Farmer
4. Business executive or owner of a small business
5. Homemaker
6. Forester
7. Conservationist
8. Coal miner
9. Oil company executive
10. Private citizen
11. Student

NATIONAL ROLES

Set up problems on a national and international basis, such as an OPEC oil embargo, war in the Middle East, threatening bankruptcy of an European nation because of the energy situation, threatened takeover of the United States stock market by OPEC.
Possible roles:

1. A United States citizen
2. A member of the United States Congress
3. Secretary-General of the United Nations
4. An OEPC leader
5. British prime minister
6. Leaders of the United States, Soviet Union and China
7. Leader of a nation whose energy consumption is only 1/20th that of the United States

Some research and discussion may be necessary before playing some of the above roles.

Student Worksheet

ENERGY INTERVIEWS

Divide into 5 equal-sized groups. Each group is to conduct one of the following interviews. Be prepared to share your interview results with the class during discussion or by group presentation.

INTERVIEW I

Involve all the group in developing questions to be used in the interview. The sample of persons to be interviewed should represent a range of ages and occupations such as: homemaker, student, store owner, service station operator, trucker, salesman, custodian, etc.
Questions might include such as the following:

1. In your judgement is there really an energy problem?
2. If there is a problem, whose fault is it?
3. If there is a problem, what can you do about it?
4. What, if anything, are you doing about it?

After the survey is completed, discuss the following:

1. How perceptions of the energy problem differ.
2. Do these perceptions vary according to income level, age, or other criteria?
3. Are there any agreements as to what could/should be done?
4. Write a few paragraphs on what you have learned about community attitudes about the energy problem.

INTERVIEW II

Review with your group the concern and pleadings from the President of the United States and other high government officials that the nation curtail energy use. Develop with the group a list of activities in the community that use substantial amounts of electricity. The list would probably include homes, supermarkets, schools, service stations, public buildings, restaurants, motels, hotels, department stores, hospitals and possibly manufacturing companies.

Observe your homes and one of the other places carefully to determine if efforts are being made to save energy. Interview the manager or some other responsible person to ascertain what is being done to save energy that might not be obvious to an observer. Give a brief oral report to the class on your findings. Does it appear that most homemakers and establishments are cooperating with the request to save energy? If the answer is no, what ideas can you propose that might get better cooperation?

INTERVIEW III

We can relearn the values of simplicity, tranquility and balance. Interview your grandparents or older members of your community to gain some insight into energy-use patterns of 30, 40, and 50 years ago to determine:

1. The size of the community (then and today)
2. The energy-requiring devices used
3. Differences in life-style
4. Differences in energy cost
5. Mode(s) of transportation, energy requirements, products, waste products
6. Thoughts on natural resources and conservation

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Student Worksheet

ENERGY INTERVIEWS
(Continued)

INTERVIEW IV

While it is taking fewer and fewer years for the world's population to double, Americans are using more and more machines and appliances. All of the electrical and natural gas appliances in your home use energy. Many of them were bought only recently. Develop a list of appliances you have in your home now; ask your parents if they had each appliance when they were younger - about 1950; and then ask your grandparents which of these appliances they had when they were young - around 1915. Upon completion of this chart, your checks will give you an indication of why Americans are using record amounts of energy.

ITEM	1915	1950	Now	ITEM	1915	1950	NOW

INTERVIEW V

Give this survey to a varied group of people. Have these people read each of the following statements carefully. Each one suggests a way to encourage the use of less energy by Americans. Have them decide if they agree, disagree, or cannot make up their mind about the statement. Before each statement have them:

Place an A if agree.
Place a B if disagree
Place a C if cannot decide

_____1. Raise the price of gasoline by $1.00.

_____2. Raise the age, to 21, at which a person can drive.

_____3. Close all businesses on Sunday.

_____4. Ban the use of recreational vehicles such as minibikes and motorboats.

_____5. Close school in December and January and open it in the summer.

_____6. Provide free public transportation.

_____7. Place tolls on all major roads.

_____8. Keep the temperatures in all public buildings at 65 degrees Fahrenheit in winter and 78 degrees in summer.

_____9. Lower anti-pollution requirements.

_____10. Encourage less use of energy-using appliances.

LESSON #41

CATEGORY: Sources

ENERGY TYPE: Fossil Fuels

TITLE: Graphing and the Economics of Energy Demand and Supply

GRADE LEVEL: 9-12

INFUSE WITH SUBJECT AREA:
Science
Social Studies

TIME NEEDED: Two periods

MATERIALS:
None

As with all products and services, the price of energy in this economy is influenced by the market forces of supply and demand. Individuals make private decisions to produce, use, ignore, consume or conserve energy when energy prices change. Many of these decisions are predictable. As prices rise consumers consume less energy or switch to energy substitutes. When prices fall consumers use more energy than they did at the higher prices. When energy prices rise producers supply more energy than they did at lower prices. When prices fall they produce less energy than they did at higher prices.

OBJECTIVES:

1. The students will be able to identify the parts of graphs and their functions.
2. The students will learn basic economic concepts of supply and demand based on energy data.
3. The students will construct graphs using tables of energy data.

TASK ANALYSIS:

The students should be able to form small discussion groups, to read and understand energy data, and to reach decisions and form conclusions.

PROCEDURE:

1. Preparation
   Read Teacher Background Information (41.3 - 41.6).
   Duplicate Student Worksheets 41.7 - 41.18.

2. Steps in Lesson
   Objective #1: The students will be able to identify the parts of graphs and their functions.

   a. Students should read Worksheet 41.7 and write four summarizing sentences as directed on the worksheet. Discuss how graphs and tables are useful.
   b. Teacher may take a random sample of ten summary sentences from the class and put them on the chalkboard.
   c. Students should read Worksheet 41.8 and answer questions on Worksheet 41.9 (answers on 41.9a).

This lesson taken from "Energy Trade-offs in the Marketplace", Washington State Superintendent of Public Instruction; adapted by Helen Holmes and Alan Peek.

d. Discuss the following questions calling for students to make inferences from the graphs.

   Making Inferences from Graphs A and B.

   -According to these graphs does *GNP product and energy use change in the same direction or do they move in opposite directions?

   -How important does energy use seem to be for producing the GNP?

   -Make an educated guess. Can the U.S. economy continue to produce high levels of GNP if we reduce our use of energy?

   -Make another guess. Do you think we have a high level of production (GNP) because we use a large amount of energy or do we use a large amount of energy because we have a high rate of production? Why might it be helpful to find the answer to this question?

*GNP stands for Gross National Product, a country's total output of goods and services valued at market prices.

Objective #2: The students will learn basic economic concepts of supply and demand based on energy data.

a. Students should read, study and discuss in class the informational reading material about the economics of demand (41.10 - 41.11) and supply (41.13 - 41.15).
b. The teacher may decide to lecture from the student information on Worksheets 41.10 - 41.15 and Teacher Background Information pages 4.3 - 41.6.
c. Follow readings or lecture with a class discussion.

Objectives #3: The students will construct graphs using tables of energy data.

a. Students should complete the graphs on Worksheets 41.12, 41.16, 41.17 following directions at bottom of Worksheet 41.11. Answers are on 41.12a.
b. Students may work in pairs to answer the review questions (41.18).
c. Discuss the review questions in class (answers on 41.18a)

3. Evaluation

Teacher may evaluate all graph work throughout the lesson and Student Worksheet Review Questions.

4. Follow-Up Activities

Use current energy data from newspapers, magazines, T.V. documentaries, Economic Report of the President and others to graph data and to extend the students understanding of supply and demand.

TEACHER BACKGROUND INFORMATION

Source:

Ila M. Nixon, Economic Education for Arkansas Elementary Schools. Little Rock Public Schools, Arkansas State Council on Economic Education and Arkansas Department of Education. Little Rock, 1977.

Washington State Department of Public Instruction. Energy Tradeoffs in the Marketplace. Spokane. 1980.

Satisfying people's wants and needs for goods and services is the end purpose of economic activity. It is what economics is all about. The basic fact which every economic system faces is the lack of enough productive resources to satisfy all of the wants of the people. This gives rise to the problem of scarcity which gives rise to the need for economizing, that is, for allocating available productive resources, so as best to satifsy the wants of the people.

HUMAN WANTS	PROBLEM OF SCARCITY	RESOURCES
1. Numerous	can only be satisfied by	1. scarce, relative to human wants
2. Can be satisfied in different ways		2. Can be used in different ways

Since all societies are faced with the same basic economic problem of economizing or allocating scarce resources among alternate uses, each society must have some organized way of making decisions as to how to use scarce resources.

WHAT TO PRODUCE	ECONOMIC SYSTEM DECIDES HOW TO PRODUCE	WHO GETS WHAT IS PRODUCED

The way in which a society makes decisions determines the kind of economic system it supports.

The economic goals of our own economic system, which have changed over the years and have been arrived at by the voice of the people through their past political and economic decisions, should be known to the teacher as students are helped to determine what the goals of democracy should be. Definition of the goals should not be drummed into the minds of the students as memorized facts. Rather this time should be spent on ways of resolving conflicts that arise in any area of relationships, whether or not they are economic by nature, and developing conceptual understanding of the terms in other settings.

At such a time as experience in reasoning has prepared the students to find something concrete in conflict, the goals will begin to make sense.

Despite the fact that students are orientated to the notion that nothing is scarce except money, it is possible to make clear that what are really scarce are the productive resources out of which goods and services are made. Resources can be defined, but they are sometimes so interrelated that distinction between them becomes fuzzy. It takes people, tools, and raw materials to produce anything. What should be of concern is that they understand, through many experiences, that economizing means making the best use of these scarce resources because resources to satisfy our wants are limited, therefore not free for the asking. Hence we must choose among the possible alternative uses to which these resources can be put -- whether to save, or spend our allowance or earned income on one item or another.

Related very closely to both of these understandings is the concept of Opportunity Cost. (If resources are used to satisfy want No. 1, they cannot be used to satisfy want No. 2; hence the real cost of Want No. 1 is the opportunity of satisfying Want No. 2 with the same resources.)

Just as the role of business enterprise in production is emphasized, so should the role of labor be examined. It is very important that students not think of labor only as a factor involving physical effort; nor should they think of farmers only as manual laborers on a farm. The roles of both have changed with new sources of power and technology, as has the output of both. Human resources should be thought of as being dynamic, not static; they are capable of growing in utility as we conserve, develop and allocate them wisely.

Our own economic system, which we describe as the private enterprise market approach, is called by several different names -- Free Enterprise, The Market Economy, and American Capitalism -- all of which add up to the same thing: decentralized market decision making.

Additional Background Information to aid the teacher in discussion.
The following is an excerpt from a speech given by Helen Holmes to the Women in Energy organization, February 1981.

In the United States the market is not sensitive to the increasingly high price of gasoline. Demand for petroleum in inelastic. When a product is elastic, the consumers respond to a small price increase by reducing their purchases substantially. When the consumer behaves in this way, there is a substitute product available and there is a competition among sellers. In addition, the product is usually not a necessity. For example, when butter cost 70¢ a pound many people will buy it; at $1.00 a pound far fewer people buy it and at $2.00 a pound most people will give up butter for margarine. As margarine goes up in price fewer people will buy it and some do without both butter and margarine. So if we can substitute for a product, or do without it, it is said that the market is elastic, i.e., the public is sensitive to price changes. Obviously this is not the way we have reacted to gasoline prices.

Petroleum products are inelastic. We cannot substitute for them nor can we do without them. Price has not affected the quantity used. We haven't bought less (at least not yet) and we don't know at what price the amount bought would be less. When and if the price is reached, the revenues for the oil companies will be multiplied immensely. So we see that peope have not changed in their basic use of energy. Price may have forced some reduction in sales, i.e., conservation, but only by those who cannot afford it.

The basic characteristics of the economic system are:

1. Private ownership of property
2. Economic gain as the motivating force
3. Consumer direction
4. Competition as a regulating force
5. A minimum of government influence and control of the market
6. Stable government by law

In a market economy it is the consumer by his demands (dollar vote) at the market, primarily, who decides what will be produced. Under the pressure of competition, the producer decides how production will be carried on. Economic institutions are creations of humans for humans, devised to help the economy move foward smoothly and efficiently. We have already mentioned the institutions of private property ownership, decision-making through the market, and the regulation of economic activities through competition instead of central authority.

Now we must make mention of a fourth institution, which is the financial institution. In this connection the commercial bank comes immediately into focus, but other savings institutions such as savings and loan associations and life insurance companies should also be included. Financial institutions serve many purposes but the common characteristic of all of them is that they are the means of channeling money from savers to investors.

The share (for whom) each individual, family, business, or government gets is determined by income and willingness to buy. To understand how income and production interrelate with each other and how a decentralized system answers these questions -- what, how and for whom -- a circular flow of goods and services and money can be used at the secondary level by moving from a simplified model at the basic level through the additional levels of understanding to a more complete model.

People from households go to the market as sellers of the factors of production to earn income, and to the market as consumers to buy finished products or capital equipment (spend income). Businesses go to the market to see what they have produced, but first they had to go to the resource market to get the factors of production they needed (land, labor, and capital tools) to produce the goods and services the people want to buy.

Given the overriding element of scarcity, the core of most economic issues in a market economy is the need to make intelligent choices among competing alternatives. Students come face to face with such issues every day. History is full of events in which the problem of coping with the fact of scarcity through choices in the main issue.

One of the purposes of studying economics is to develop a way of making rational choices, whether we are dealing with economic or other kinds of problems. As students learn national and global history and geography they will discover that in our nation we have not always had as many choices as we have today and that people in different parts of the world have different numbers of choices. We have relatively more choices than people in other nations. One of the main reasons for this is our advanced stage of technology; also the privilege we have of making individual decisions at the voting booth.

TEACHER BACKGROUND INFORMATION
(Continued)

Because of the basic assumption of scarcity brought about by the fact that we do not now have enough productive resources to produce all the goods and services man wants, man has attempted to extend the resources through institutions, specialization, technology, and entrepreneurship.

From the point of time in the history of any nation when production moves away from muscle power and self-sufficiency toward invention, discovery, and specialization of all productive resources, the impact of interdependence which necessitates trade should be discovered and emphasized. Here again common sense runs hand in hand with economic reasoning. What would you think two people or two nations would do if each one had a surplus of different kinds of goods?

Once students understand the need for choice-making in economizing, saving, and considering opportunity cost, the next step is a logical one which explains the use of a set of analytical tools to be used in making such choices.

Training in economic analysis does more than just contribute to the students' understanding of how our economic system operates. It develops capacity to base choices among competing alternatives on reasoning rather than emotions or immediate desire.

It also develops awarenenss that things do not just happen -- that work is important -- that trees have to be grown, inventions have to be developed, materials for building cars have to be imported, research has to be carried on, and people have to be trained for their job in production, and to earn a living. The reasoning process is an unfolding of meanings, each of which raises a new set of inquiries. Beginning of inquiry may originate in the textbook or in any other experience, but the importance for analysis is that the inquiry itself becomes an experience in reasoning.

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Student Worksheet

READING GRAPHS AND TABLES I

The field of energy information is enormous. A student of the subject can become overloaded with facts and never arrive at the answers he or she was seeking. To overcome that problem students must develop two skills: asking the right questions and understanding how to read graphs and tables.

Asking the right questions means that an investigator has thought about the subject and decided what he/she would like to find out. By placing these decisions into question form, a student can quickly look over information and only concentrate on facts that relate to the questions.

Reading graphs and tables is useful to an investigator because they are efficient ways to present information concerning matters of quantity. Look at the graphs in Figure 1. Imagine how many sentences it would require to communicate the same information in complete sentences.

Write four sentences summarizing the information shown in the graphs below.

Changing Patterns in the Use of Energy Resources in the United States

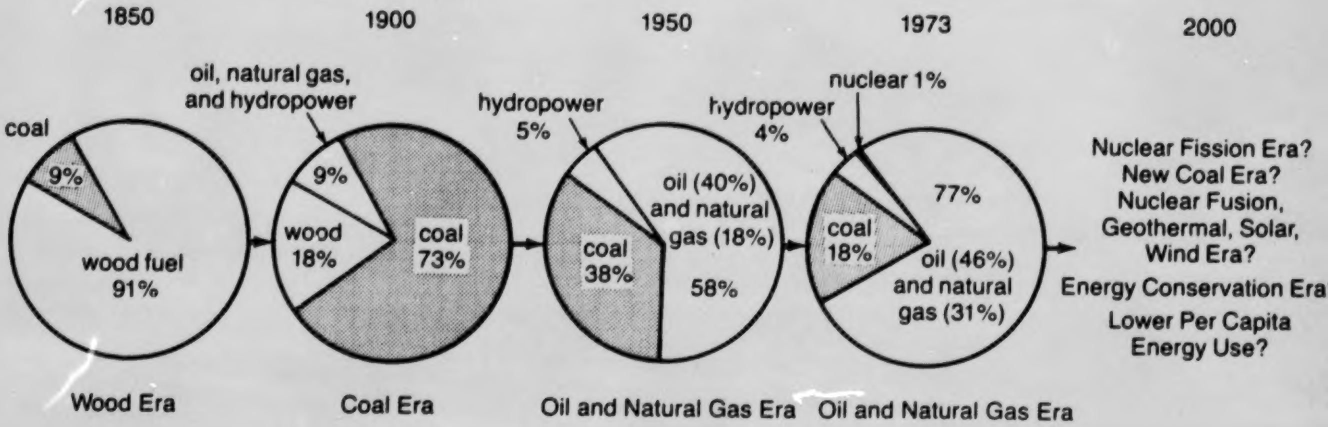

Figure 1

Data Source: U.S. Bureau of Census and Resources for the Future

Student Worksheet

READING GRAPHS AND TABLES II

Graphs and tables usually appear to be quite complex, abstract and overwhelming. Any complex graph, table, chart, map, or any research problems may cause you frustration and to ask, "where do I begin? How am I ever going to do this?" The trick is not to look at the whole task. Concentrate on one thing at a time and for the moment ignore all other parts of the graph.

Take on the task one step at a time and you will enjoy greater success and develop skill in handling graphical information.

1. Begin with the title. Read this carefully so you know what subject the graph is containing information about. Often people try to make the graph relate to something it does not even deal with.
2. Identify the labels (categories) on the horizontal and vertical axes. These will tell you what is being compared and how the comparisons are made.
3. Extract the facts from the graph.
4. Then draw inferences from the graph and evaluate the data.

Now practice these steps on the following two graphs in Figure 2.

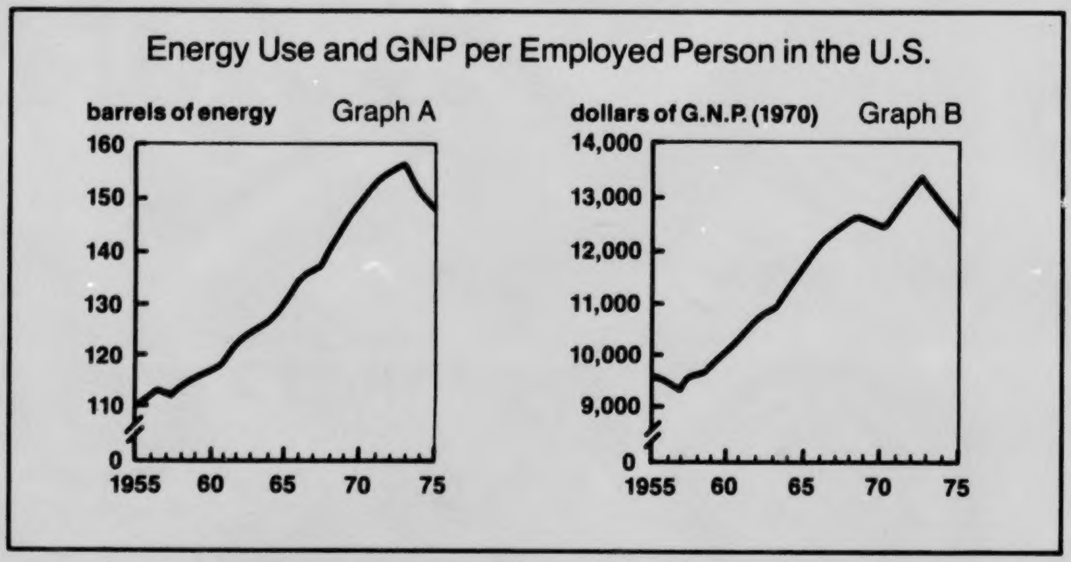
Energy Use and GNP per Employed Person in the U.S.

Figure 2

Data Source: Chase Manhattan Bank

Student Worksheet

READING THE FACTS IN GRAPHS A AND B
(Figure 2)

1. A good title will tell you what information you should find on a graph. What information do you expect to find in Graphs A and B?

2. What are the titles on the vertical axes of the graph?

3. What are the titles on the horizontal axis of the graph?

4. What is included in a category like barrels of energy?

5. What is included in a category like dollars of GNP (1970)?

6. The lines indicate how much energy was used and how much GNP was produced by each employed person in the U.S. How much energy was used in 1955, 1957, 1965, 1972, and 1975? Compare your answers with those of another student.

Student Worksheet

READING THE FACTS IN GRAPHS A AND B
ANSWER SHEET
(Figure 2)

1. Energy use per employed person in U.S., GNP per employed person in the U.S.

2. Barrels of energy
   Dollars of GNP (1970)

3. Years 1955-1975

4. Amount of energy used that comes from all sources and forms of energy (electricity, natural gas, nuclear power, coal, hydroelectric, solar, petroleum). All these categories have to be put into a common measurement and added together. Then the total was divided by the number of people employed in the U.S. to get an average number of barrels used per person employed for every year.

5. This is the dollar value of all final products and services sold in the U.S. in one year (GNP) divided by the number of people employed in the U.S. Gross National Product includes cars, toys, barber services, soft drinks and anything else we pay more for and consume.

7. Compare your answers with another student.

Student Worksheet

The concepts of supply, demand and price are useful when analyzing the economic actions involved in energy use. They give meaning and clarity to the diverse human behavior associated with the use of energy. Unfortunately these concepts are often used in a confusing manner by writers and speakers, therefore it is important that students learn the correct definitions of these concepts and the accurate applications of these concepts to explain economic issues of energy use. Clarifying these terms and using them correctly is one of the purposes of this lesson.

Demand

Demand is the willingness and ability of people to purchase energy at various prices. Consider that definition carefully; it identifies three important characteristics of demand. They are willingness, ability and price. Each of these characteristics influences the purchasing behavior of consumers. First of all, price identifies the value of energy compared to other valuable economic products and services in the economy. The price indicated on the heating bill, once a month, allows a consumer to compare the cost of energy used to heat their house, with the value of other products that they consider important, such as food, clothing and shelter.

Willingness is the second important characteristic which influences consumer purchasing decisions. Most consumers are financially able to buy $80.00 of electricity or a $40.00 basketball or a $160.00 portable radio, but many consumers refuse to buy all three products. They have the ability and the price is not prohibitive, but they are unwilling to spend their money in this manner. For example, some individuals who would like a portable radio may have no interest in basketball! Likewise, some people would rather turn down their electric furnace than give up playing pinball. In each case consumers are able to purchase the product but choose not to because they are unwilling to use their income in that manner.

The last characteristic influencing consumer purchasing power is financial ability. Sometimes consumers are willing to pay for a product and the price is acceptable, but they do not have the income to purchase the product. Many people are willing to buy an isolated south sea island paradise and even consider the one million dollar price tag as appropriate, but in the end, conclude they could not afford the purchase. In like manner another individual may be willing to buy a house and agree to the purchase price of the house but still is unable to save enough money for a down payment. Therefore, financial ability is a characteristic that influences consumer purchasing power.

Taken together, these three characteristics allows us to predict what will happen when people are offered the opportunity to purchase a product. For example, economists have observed over the years that people demand fewer products at higher prices than they do at lower prices. At a low price people tend to use a greater quantity of whatever product is for sale. As the price rises a number of people are unwilling or unable to purchase that product, they stop buying the product all together, they buy less of it or shift their demand to alternative products. For instance, as the price of musical concerts by popular groups become higher and higher, many individuals stop purchasing rock concert tickets and purchase records containing the same music. In this manner they can still enjoy the music but do not have to pay the high price of the rock concert ticket. Observe Figure 3 and schedule to see how this concept helps explain how people decide to purchase electricity.

Looking at Figure 3 you can observe that people buy more electricity at 1¢ per kilowatt hour than they do at 5¢ per kilowatt hour. This conclusion is consistent with what we learned about demand, that people will buy more of a product at a lower price than they will at a higher price. As the price moves from a low price to a higher price, we see that people either stop buying electricity, or more likely, they will not use as much of it. They find some way to conserve, either by insulating their house, by turning off lights and by reducing their use of electrical appliances. In some cases they turn to substitutes. A substitute is a product that satisfies the same desire but in a different manner. If this community normally heated their homes with electricity, now people may switch to other means of home heating, thereby reducing the amount of electricity normally consumed. For instance, they may buy a wood stove and use that to heat their house. They may replace their electric water heater with a gas water heater, or convert to solar heat. Each of these activities will allow them to substitute the use of one form of energy for an alternative energy form to meet their demand for warmth, hot water and light. The higher price for electricity indicated a higher relative value of electrical energy, therefore people began to reduce their use of it and switch to alternative means to satisfy their desire for energy use.

After reading about demand and supply on Worksheets 41.10 - 41.15, complete the graphs as directed below:

*Draw the vertical and horizontal lines on the graphs on Worksheets 41.12, 41.16, and 41.17.

*Plot the demand curve (on 41.12) using the data in Table I.

*Plot the supply curve (on 41.16) using data in Table II.

*Plot the demand and supply curves (on 41.17) using the key found on the bottom (i.e. solid line for supply, broken line for demand). Use data in Table II. Give the graph a title.

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Student Worksheet

TABLE I

DEMAND FOR ELECTRICAL KILOWATT HOURS PER COMMUNITY

Price	Amount of Kilowatt hours
1¢	100,000
2¢	90,000
3¢	70,000
4¢	50,000
5¢	45,000

GRAPH

DEMAND FOR KILOWATT HOURS

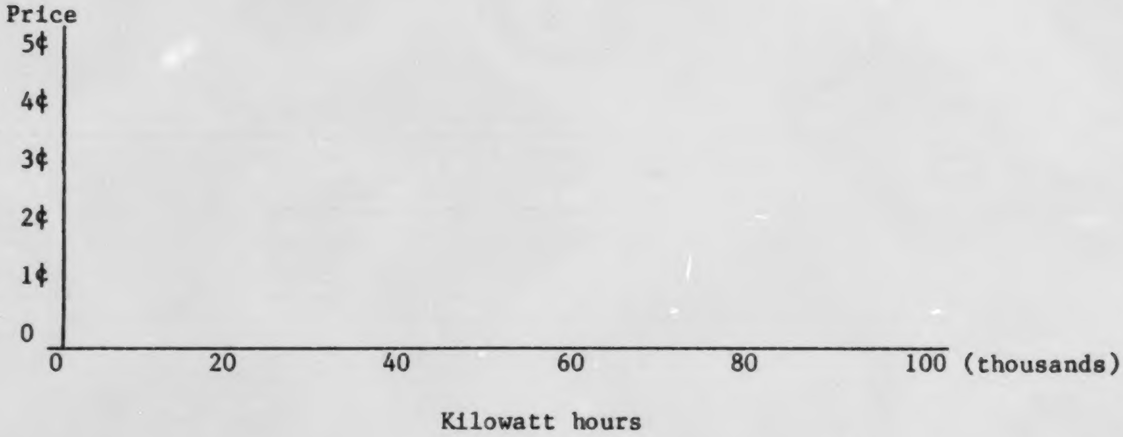


Figure 3

Student Worksheet

ANSWER SHEET

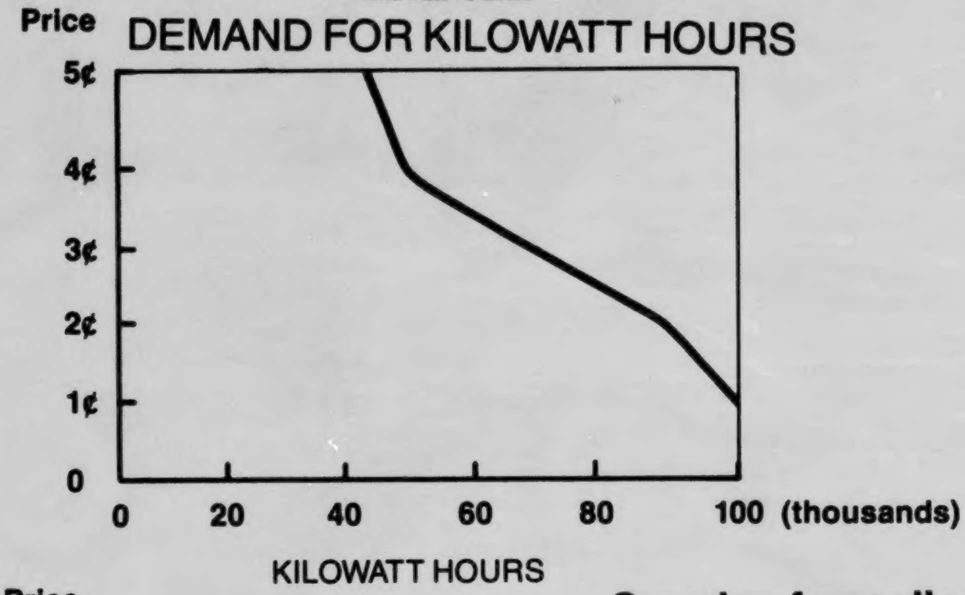


Figure 3

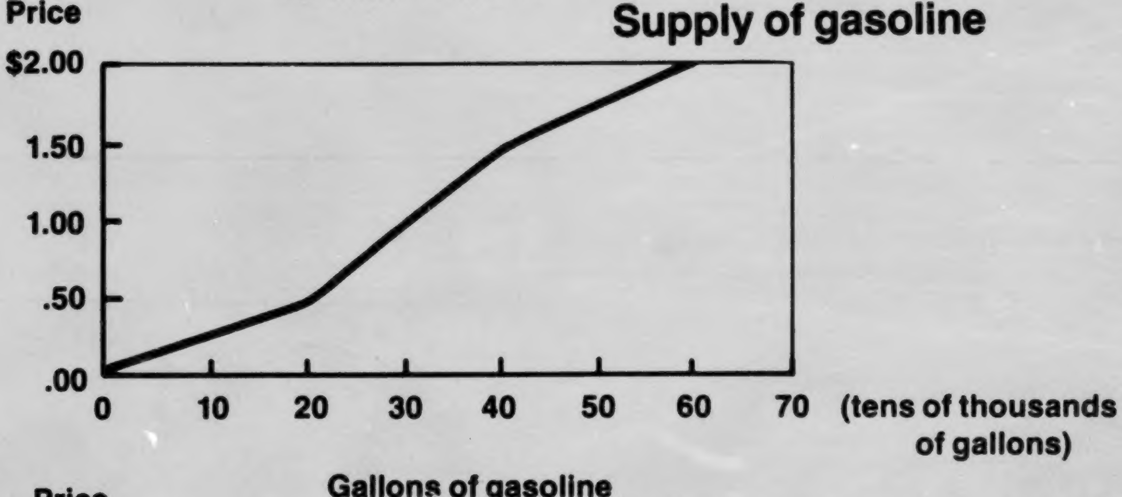


Figure 4

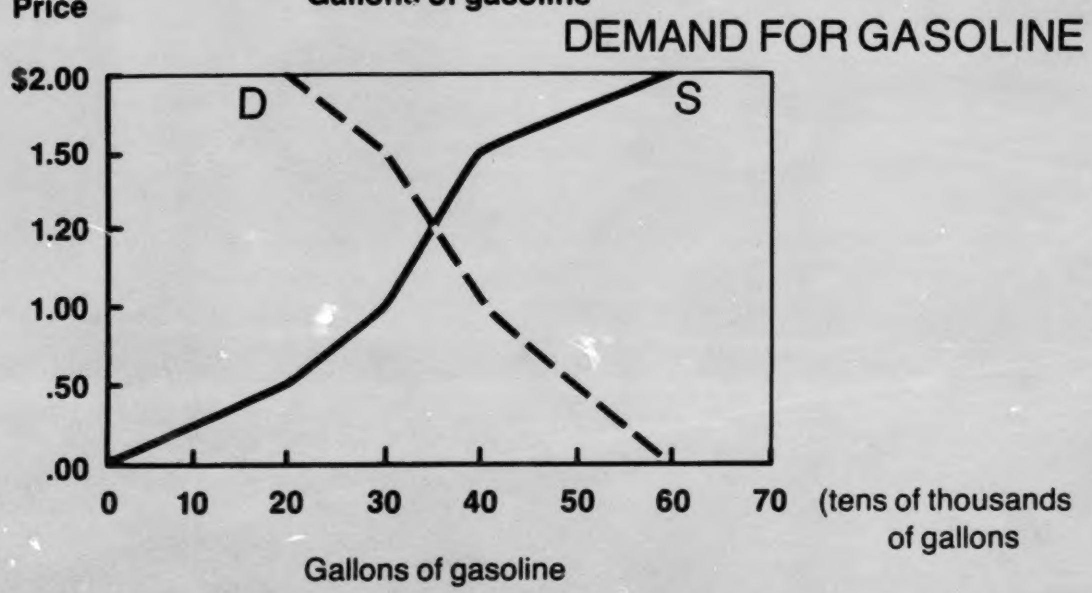


Figure 5

Student Worksheet

Supply

Supply is a concept used to explain the economic behavior of producers. Supply is the ability and willingness of producers to provide products or services at specific prices. For instance, gas station operators are willing to pump more gasoline at $2.00 a gallon than they would be at 50¢ a gallon. If gasoline prices change from $1.20 a gallon (the current average price) to 50¢ a gallon many station operators would either quit selling gas, go out of business, or concentrate on other activities that paid a greater return. Each of these activities would have the result of producers providing a smaller amount of gasoline because the price of gasoline had gone down. Conversely if the price of gasoline increases from the current average price of $1.20 to $2.00 a gallon, more gasoline operators would try to sell additional gasoline and spend less time with other activities like fixing cars, selling maps or talking with friends. In addition, other people encouraged by the higher price of gasoline would try to enter the gas selling business by buying a gas station or building a new gas station or adding pumps to a current business location. Many grocery stores have already done this. Observe Figure 4 to see how this supply behavior can be illustrated graphically.

The generalization drawn here is this: at higher prices producers are willing and able to offer for sale more gasoline than if the price was lower. Notice that the same characteristics affect producers that influence consumers in an opposite manner. The price indicates the relative value of various products, producers must be willing to provide the products and finally they must be able to afford the cost of producing the product.

So, we reach the conclusion that suppliers and consumers decisions are influenced by the same factor. These are ability, willingness and price. Also the same factors that encourage suppliers discourage consumers and those factors which encourage consumers discourage suppliers. Producers will make more at high prices while consumers will purchase less. Consumers purchase more at lower prices while producers produce less at lower prices. How can such a situation work out to satisfy anyone? The answer is both producers and consumers compromise in a market situation.

It is in markets where these differences are reconciled and the basic economic problem of scarcity is confronted. Scarcity is the most important concept in economic analysis. It simply states that people with unlimited wants and needs live in a world of limited resources, and there are not enough resources to satisfy all the possible wants of people. Therefore, we must make choices on what to produce and what to consume. Citizens cannot have all of the electricity or gasoline they desire, nor can suppliers produce all of the electricity or gasoline they may wish to make. How, then is it decided to ration the available resources. This decision making is done in the market, where buyers and sellers make independent decisions on what should be purchased and sold. This is depicted by placing the supply and demand curves on Figure 4.

Student Worksheet

Market Clearing Price

How much gasoline will be bought and sold in the situation is depicted in Figure 4. Thirty-five thousand (35,000) gallons of gasoline will be demanded and supplied if the price is $1.20 per gallon. At that price producers are willing and able to produce the same amount of gasoline as customers are willing and able to purchase. At this price the market is cleared. At a price lower than $1.20 consumers are trying to buy more gasoline than suppliers are willing and able to make available. Look at the price of $1.00, at that level consumers are willing and able to buy 40,000 gallons of gasoline, suppliers are only willing to supply 30,000. That is a gap of 10,000 gallons of gasoline. Remember the gasoline lines in 1979? At that time the price was below the market clearing price. Consumers were trying to purchase more gasoline than suppliers were willing and able to provide, therefore, there were long gasoline lines while people tried to cope with a shortage.

In the same manner, who is a supplier of gasoline in this situation? A supplier is anyone willing and able to supply gasoline at $1.20 or less. At that price the amount suppliers are selling is the same as the amount that customers are willing to purchase. If the price was more than $1.20, more gasoline would be available than what people wish to purchase. Remember the summer of 1980, when gasoline prices dropped from an average of $1.25 to $1.20 per gallon? Suppliers dropped the price because it was too high and a surplus developed. Imagine for a minute that the price had been $1.50, as in our example, that means that it would have consumers demanding 30,000 gallons of gasoline while suppliers would have 40,000 gallons of gasoline available for purchase. That means that there would be a surplus of 10,000 gallons that would have to be stored in gas stations in this community. The only way to sell that surplus would be to drop the price, and it wasn't until the price dropped in 1980 that gas station operators were able to sell all of the available gasoline. The same situation occurs during clothing sales, after-Christmas sales, and auto rebates. Each of these techniques are used by sellers to find a price where all of there merchandise will be sold to customers.

This analysis using the concepts of supply and demand as they interact in the market helps investigators understand where prices on products, including energy, come from, and where they will stabilize. In this case it is where the amount demanded by consumers at a price equals the amount provided by suppliers at that price. At this level the market is cleared. It also illustrated how prices can change as they have done in the energy market. In 1973 the Arab boycott changed the supply curve for gasoline. The Arab nations held their petroleum from the world market. All producers had to restrict the amount of gasoline and other petroleum products from the market at every price level. Therefore, at any price, suppliers were willing and able to only provide a smaller amount of petroleum products, especially gasoline. This action shifted the whole supply curve upwards and to the left. If you would take the amount of gasoline supplied which was used in the last example, and at every price have the amount supplied be one-half of what it was before (i.e. at 50¢ there would be 10,000 gallons available, at $1.00 there would be 15,000 gallons available, and so on) then draw a line on the graph, you will see what happens to the market price of gasoline. The market price of gasoline also rises. In our example the market or clearing price would be approximtley $1.75 and 25,000 gallons of gasoline would be consumed. In this situation we see that a cut in supply influenced the price to rise and make only 25,000 gallons available for consumers. At that price a smaller number of consumers were willing and able to buy gasoline. This same situation occurred in 1979 when Oil Petroleum Exporting Countries agreed to raise the price of petroleum, and restricted their supplies to the world market.

In summary, demand is the amount consumers are willing and able to purchase at different prices. Supply is the amount producers are willing and able to provide at different prices. In the market these two factors work together to identify a clearing price. At this price the amount demanded and the amount supplied are equal. This price will change only if the amount supplied changes or the amount demanded changes. In the 1970's we saw a very drastic change in supply. This action raised the price and encouraged United States consumers to reduce the amount of gasoline they purchase and to find alternative sources of energy for their use. These alternatives are wood, coal, shale oil, nuclear power, solar energy, and devices to use energy more efficiently. This use of substitutes is encouraged by markets as prices change and people adjust to these changes.

Student Worksheet

TABLE II

SUPPLY OF GASOLINE

Price	Gallons of Gasoline
$2.00	60,000
1.50	20,000
1.00	30,000
.50	20,000

GRAPH

SUPPLY OF GASOLINE

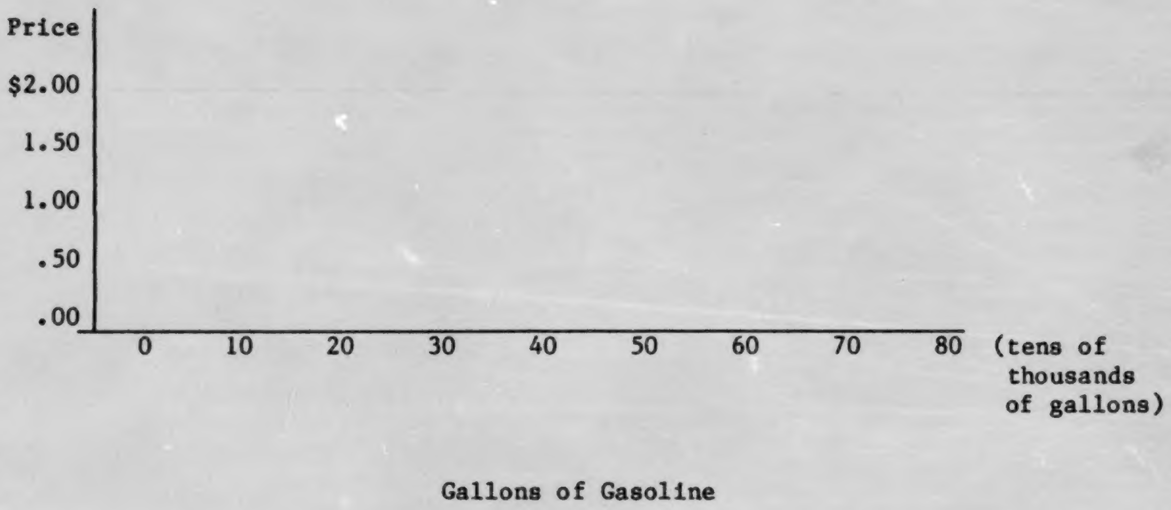


Figure 4

Student Worksheet

TABLE III

DEMAND FOR GASOLINE

Amount Demanded	Price	Amount supplied
20,000	$2.00	60,000
30,000	1.50	40,000
35,000	1.20	35,000
40,000	1.00	30,000
50,000	.50	20,000

GRAPH

TITLE:

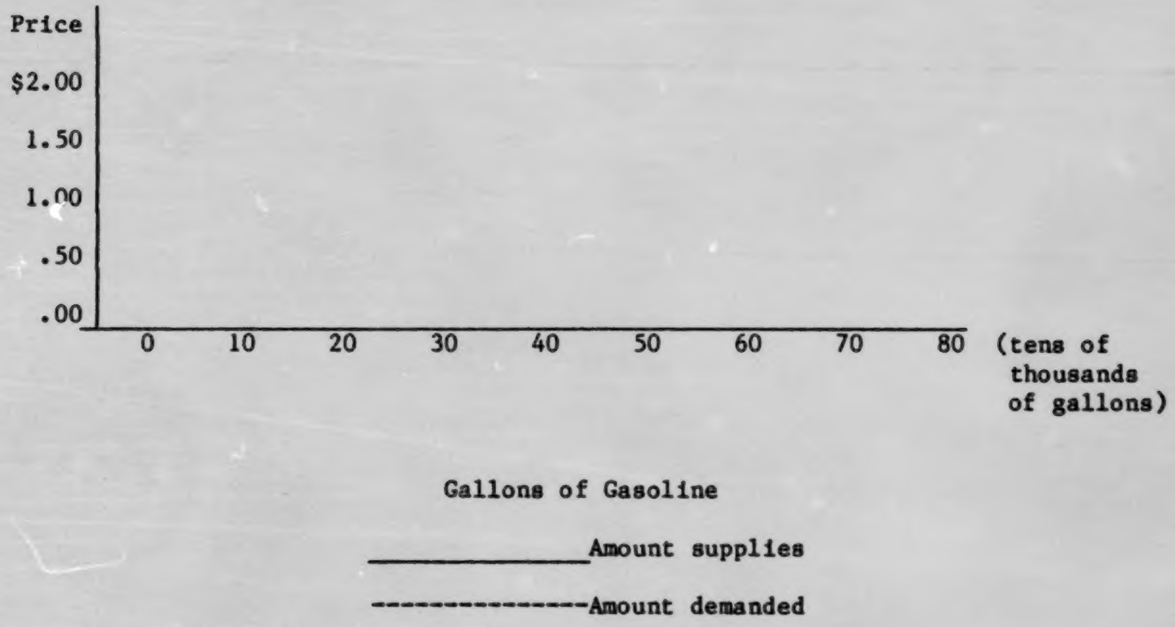


Figure 5

Student Worksheet

REVIEW QUESTIONS

1. How has the United States changed its energy use from 1850 to the present?

2. How important is energy use in the economic production of this nation?

3. What techniques are useful in reading graphs and tables?

4. What is the basic difference between supply and demand?

5. What are the three characteristics of demand?

6. Why do people buy more electricity at 1¢ per kilowatt-hour than at 5¢ per kilowatt-hour?

7. How can willingness, ability and price affect suppliers and consumers oppositely?

8. How can a market be cleared?

9. In 1979, Oil Petroleum Exporting Countries agreed to raise the price of petroleum and restricted their supplies to the world market. What actions could be taken so that the price of gasoline would come down as a result of market forces?

10. Name some alternative sources of energy in the United States.

Student Worksheet

REVIEW QUESTIONS
ANSWER SHEET

1. Increased use and it comes from different sources.
2. It is a critical factor of production because it affects land, labor and capital.
3. a) Note the title of the graph, b) identify the categories or the horizontal and vertical axes, c) extract the facts from the graph, d) draw inferences from the graph, e) evaluate the data from the graph.
4. Demand deals with purchasing at various prices and supply deals with producing a given product at a specific price.
5. a) willingness, b) ability, and c) price.
6. Consumers will buy more of a product at a lower price than they will at a higher price. As the price moves from lower to higher, consumers begin to conserve or find energy alternatives, or both.
7. Producers will make more at high prices while consumers purchase less. Consumers purchase more at lower prices while producers produce less at lower prices.
8. When the amount demanded by consumers at a price equals the amount supplied by the suppliers at that price.
9. The number of consumers willing and able to purchase at any price must drop considerably, or new sources of petroleum must come on the market increasing the supply. Each of these would allow the price to return to its previous level.
10. Alternative energy sources in the United States include coal, shale oil, nuclear fission, direct solar energy, biomass conversion, hydropower, wind, geothermal, nuclear fusion, and devices to use energy more efficiently.

LESSON #42

CATEGORY: Sources

ENERGY TYPE: Fossil Fuels

TITLE: Statistics Can Be Misleading

GRADE LEVEL: 9-12

INFUSE WITH SUBJECT AREA:
Science
Social Studies
Math

TIME NEEDED: One period

MATERIALS:
None

OBJECTIVES:

1. The students will be able to extract information from statistics about energy.
2. The students will critically analyze energy data noting how graphs can be misleading and show bias.
3. The students will be able to demonstrate the interrelated nature of the current energy and economic situation using graphs.

TASK ANALYSIS:

The students should be able to read graphics such as tables, charts, and graphs; to infer economic concepts from energy data or graphs; and to work in groups.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 42.5 - 42.10; optional: 42.11 - 42.19

2. Steps in Lesson
   Objective #1: The students will be able to extract information from statistics about energy.

   a. In this activity students take a closer look at the word "average" so often used by speakers and writers. Two common averages are the mean and the median. In this lesson students learn the difference between these averages.
   b. Begin by giving the definition of mean. The mean is the sum of the figures divided by the number of figures.
   c. Tell the students: "Suppose you have figured the miles per gallon you get from driving your car for one week." For example: (write the following data on the chalkboard:

Students	MPG
John	18
Sue	28
Bob	33
Jennifer	20
Lindsay	24

This lesson was written by Helen Holmes based on materials from National Science Teachers Association and from "Energy Trade-Offs in the Marketplace", Washington State Superintendent of Public Instruction.

d. Ask students: "What's next?" Add the MPG and divide by 5. What is the mean number of miles per gallon of this group of five cars? (24.6 MPG)

e. Introduce the definition of median. It is the middle number of measurement in a set of numbers listed in increasing order.

f. Tell students to use this definition and figure out the median miles per gallon for the same five students as above.

g. What is the middle number? (24) If there is an even number of values, you can find the midpoint between the two middle figures. To find this midpoint, add the two numbers together and divide by two.

h. There are situations where an "average" can be deceptive. In these cases the mean and median are very different on the same data; one type of average may be selected to "prove" a point. For example: Students were asked to keep track of the number of miles they drove their cars in a week. As a group project, they were going to figure the average number of miles students drive. The assignment was given when one student happened to go on a long week-end trip. (Put this data on the chalkboard.

Andy	30	Barb	25
Joe	36	Debby	28
George	25	Carol	45
Kevin	28	Nancy	18
Lou	42	Sandy	450

i. What is the median number of miles driven (29) (Arrange in increasing order and find the midpoint between the two middle values: 18 - 25 - 25 - 28 - 28 - 30 - 36 - 42 - 45 - 450. The midpoint between 28 and 30 is 29.)

j. What is mean number of miles driven? (72.7)

k. Which figure is more representative of a "typical" student's mileage? (the median)

l. Which figure would you use if you were trying to "prove" that students make heavy use of their cars? (the mean)

m. Hand out Student Worksheet 42.5. Like "name dropping" many advertisers and other persuaders are "number dropping". Discuss the use of statistics and percentages as students answer Worksheet 42.5 (Misleading Numbers); answers on 42.5a.

Objective #2: The students will critically analyze energy data noting how graphs can be misleading and show bias.

a. How can graphs mislead you? Students should answer questions on Worksheets 42.6, 42.7 and 42.8. Discuss the answers in class.

b. Students may be evaluated using Worksheets 42.9 and 42.10. Answers on 42.9a. Answers for 42.10 are: 1.b, 2.d, 3. The mean value because it is a larger number.

Objective #3: The students will be able to demonstrate the interrelated nature of the current energy and economic situation using graphs.

ECONOMIC GENERALIZATIONS: 1955-1980

Much of the factual information regarding energy is transmitted through the use of charts and graphs. This lesson allows an individual to check economic analysis using data drawn from economic activity from 1955-1980. Among the major generalizations students can check are these:

-As income rises faster than the price of a commodity, consumers will purchase more of the commodity.

-When income rises slower than the price of a commodity, consumers will purchase less of the commodity.

-As prices of a commodity increase, consumers will purchase alternatives.

-As the prices of a commodity and its alternatives increase, more producers will arise to produce more commodities (energy).

These statements and graphs link every information to the basic economic expectations. Students should realize that the energy issue has a large amount of information. Graph rovide an economical way of showing changes, identifying trends and describing ·terrelationships.

a. Divide students into ten groups.
   -Give Graphs I, II and III to two groups
   -Give Graphs IV and V to two groups
   -Give Graphs VI and VII to two groups
   -Give Graphs VIII, IX and X to two groups
   -Give Graphs XI and XII to two groups.

b. After careful analysis and discussion, students will develop approximately three to five sentences summarizing the information.
c. Some possible generalizations (on 42.20) are some points that students should be able to infer from their graphs. The questions below may be used to debrief the group work:

Debriefing Questions:

-What do you know from the information you analyzed? (This refers to the generalizations they develop.)

-Did the groups looking at the same graphs draw some of the same conclusions?

-If there is disagreement, why did it occur? (The disagreement may be an error in reading graphs or differences in interpretation.)

-How might the information on different charts and graphs relate? (Look for correlations -- such as energy use and high incomes.)

-Does information on one graph show an impact on information pictured on another graph? (Have students establish possible casual relationships, i.e., as the price of energy goes up consumption may stablize or fall.)

-Which information is most useful in understanding the economics of energy production and use? Why?

d. Teachers should use the Economic Generalizations: 1955-1980 listed on 42.3 as a guide in assessing student understanding. Read these four generalizations to students; ask if the data on energy supports these generalizations.

3. Evaluation

Students may be evaluated using Worksheets 42.9 and 42.10. Answers in discussion can be used as an assessment of understandings gained by students.

Student Worksheet

MISLEADING NUMBERS

A company claims "90% of all our trucks sold in the last 10 years are still being driven today."

What conclusion do they want you to draw?

If you knew that 90% of all vehicles sold in the past 10 years are still on the road, how is the conclusion changed?

If the manufacturer has just begun to manufacture the trucks four years ago, how would that change the conclusion?

A manufacturer states "This microwave oven saves you 30% more energy."

What conclusion do they want you to draw?

What do you need to know before you can really draw that conclusion?

An opponent of the mass transit system complains, "This city spent a quarter of a million dollars improving the mass transit system and the revenues were only $300,000.

What would be your first impression based on this information?

A recreational vehicle salesman states that this motor home "will go 300 miles on a tank of gas".

What is he avoiding telling you?

What do you need to know in order to compute miles per gallon based on this data?

Student Worksheet

MISLEADING NUMBERS
ANSWER SHEET

A company claims "90% of all our trucks sold in the last 10 years are still being driven today."

What conclusion do they want you to draw? (The trucks will last a long time.)

If you knew that 90% of all vehicles sold in the past 10 years are still on the road, how is the conclusion changed? (These trucks last the same as other vehicles.)

If the manufacturer has just begun to manufacture the trucks four years ago, how would that change the conclusion? (If the oldest truck is only four years old, why did that manufacturer use the ten year figure? 10% are no longer on the road, perhaps they are not very durable.)

A manufacturer states "This microwave oven saves you 30% more energy."

What conclusion do they want you to draw? (That you will use 30% less energy if you cook with a microwave.)

What do you need to know before you can really draw that conclusion? (30% more energy saved over what? An actual comparison of the kwh consumed by cooking the same meal in a microwave and in a conventional oven.)

An opponent of the mass transit system complains, "This city spent a quarter of a million dollars improving the mass transit system and the revenues were only $300,000."

What would be your first impression based on this information? (That a quarter of a million is greater than $300,000.)

A recreational vehicle salesman states that this motor home "will go 300 miles on a tank of gas."

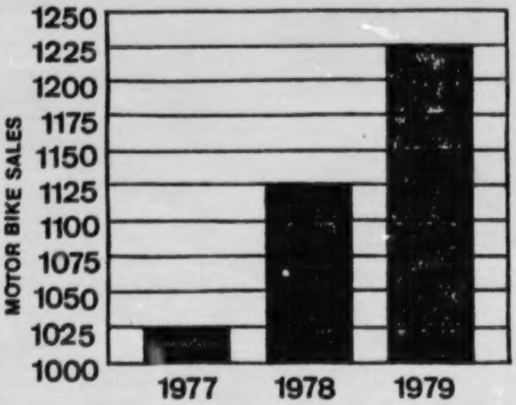
What is he avoiding telling you? (The gas mileage.)

What do you need to know in order to compute miles per gallon based on this data? (The size of the gas tank.)

Student Worksheet

HOW CAN GRAPHS MISLEAD YOU?

When a bar graph does not begin with 0 (truncated graph), one tends to see the proportion between one bar and another rather than the actual amount of difference.



MOTOR BIKE SALES ARE SKYROCKETING!

1. Bicycle sales are increasing -- what kind of increase is implied by the graph?
2. How would the effect of the graph be changed if the scale began with 0?
3. Using the following formula, what is the actual percent of increase?

$$\frac{\text{1979 sales figure} - \text{1977 sales figure}}{\text{1977 sales figure}} \times 100 = \text{percent of increase}$$

Student Worksheet

HOW CAN GRAPHS MISLEAD YOU?
MOTOR BIKE SALES ARE SKYROCKETING!
ANSWER SHEET

1. Bicycle sales are increasing -- what kind of increase is implied by the graph? (1979 looks 8 times higher than 1977.)
2. How would the effect of the graph be changed if the scale began with 0? (The amount of increase would appear to be much smaller.)
3. Using the following formula what is the actual percent of increase?

$$\frac{\text{1979 sales figure} - \text{1977 sale figure}}{\text{1977 sales figure}} \times 100 = \text{percent of increase}$$

$$\frac{(1225-1025)}{1025} = \frac{225}{1025} = .219 \times 100 = 21.9 \text{ percent increase}$$

PASSENGER MILES PER PERSON
1950-1970

1. What does this pictograph seem to imply? (The increase looks about 4 times greater.)
2. How much is the actual increase in passenger miles per person? (The miles per person has doubled.)

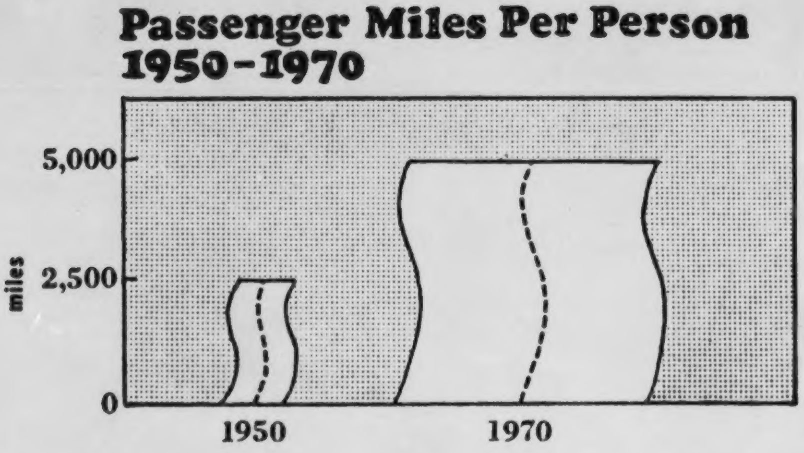
MONEY SPENT ON BIKE PATHS PER BIKE RIDER

1. What does the graph seem to imply? (There is more money spent on each bike rider in 1960 than 1970.)
2. How much does each segment increase each time? (3 times.)
3. How does the cost per rider in 1960 compare with the cost per rider in 1970? (The cost is the same.)

Student Worksheet

MORE ABOUT GRAPHS THAT CAN MISLEAD

In this pictograph the scale begins at 0, but the effect is still deceptive.



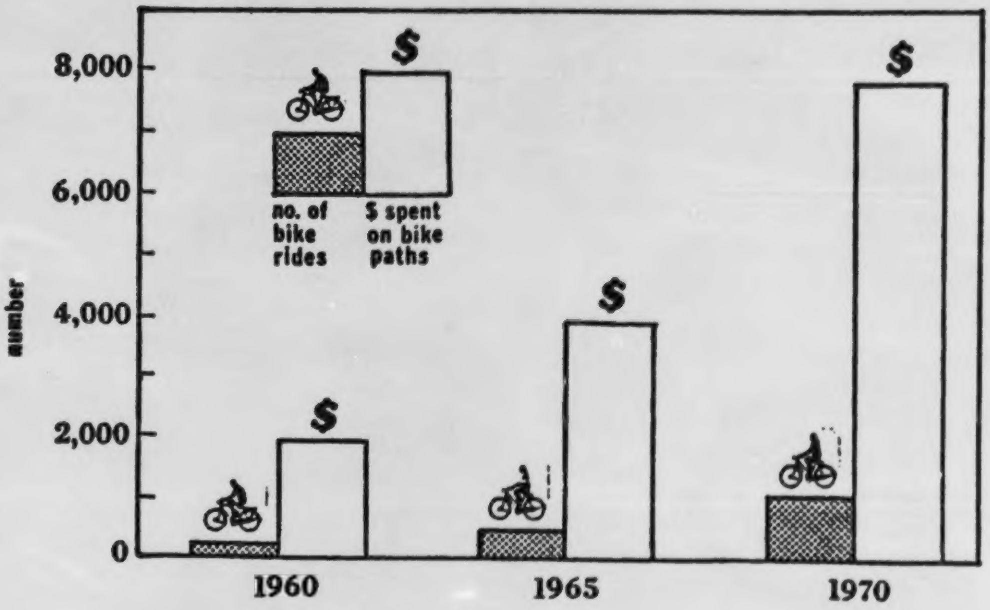
1. What does this pictograph seem to imply?
2. How much is the actual increase in passenger miles per person?

Student Worksheet

STILL MORE ABOUT GRAPHS THAT CAN MISLEAD

In this bar graph the scale begins with 0 and the bars are in correct proportion, but again, the effect is deceptive.

MONEY SPENT ON BIKE PATHS PER BIKE RIDER



1. What does the graph seem to imply?
2. How much does each segment increase each time?
3. How does the cost per rider in 1960 compare with the cost per rider in 1970?

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Student Worksheet

USING STATISTICS AND GRAPHS

You are a politician running for office in an area where gasoline conservation is an important issue. Given the following information, draw a graph to show you have saved a great deal of gasoline in the last year.

Month	Gas Consumption in gallons	Month	Gas Consumption in gallons
Jan.	55	Jul.	47
Feb.	54	Aug.	46
Mar.	52	Sept.	45
Apr.	52	Oct.	43
May	50	Nov.	42
June	49	Dec.	40

Draw a second graph the way your opposition might present the same data showing your savings to be very insignificant.

Student Worksheet

USING STATISTICS AND GRAPHS
ANSWER SHEET

You are a politician running for office in an area where gasoline conservation is an important issue. Given the following information, draw a graph to show you have saved a great deal of gasoline in the last year.

Month	Gas Consumption in gallons	Month	Gas Consumption in gallons
Jan.	55	Jul.	47
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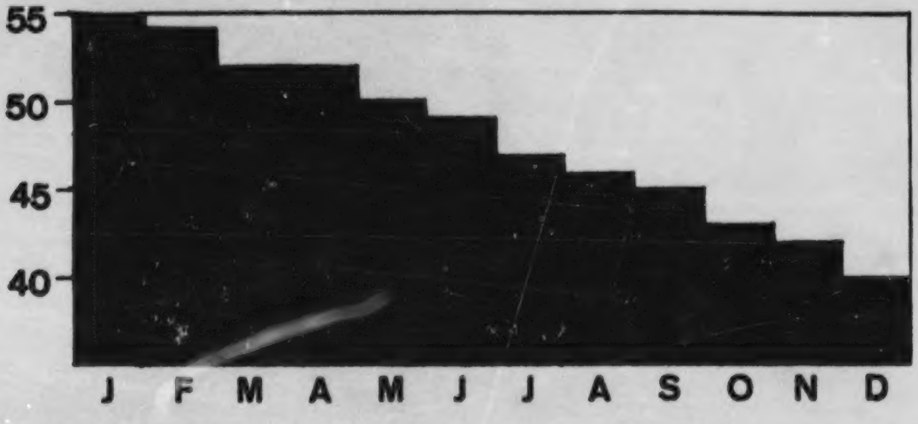
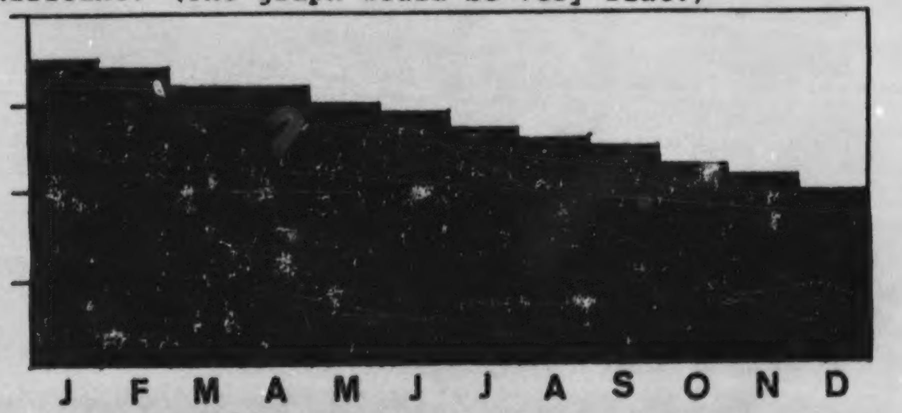
Mar.	52	Sept.	45
Apr.	52	Oct.	43
May	50	Nov.	42
June	49	Dec.	40

(The graph would be truncated and would emphasize height.)



Draw a second graph the way your opposition might present the same data showing your savings to be very insignificant. (The graph would be very flat.)



What is your percent of savings from January to December? (27%)

Student Worksheet

TESTING YOUR UNDERSTANDING OF USING STATISTICS

Information: Students were comparing the amounts of gasoline each student used in one week in their personal cars. John used 34 gallons, Sue used 16 gallons, Nancy used 17 gallons, Tom used 10 gallons and Egbert used 63 gallons.

1. Basing your choice on the information above, choose the sentence which uses the median correctly.

2. Basing your choice on the same information, choose the sentence which uses the term mean correctly.

    a. The median value for gallons used is 28.

    b. The median value for gallons used is 17.

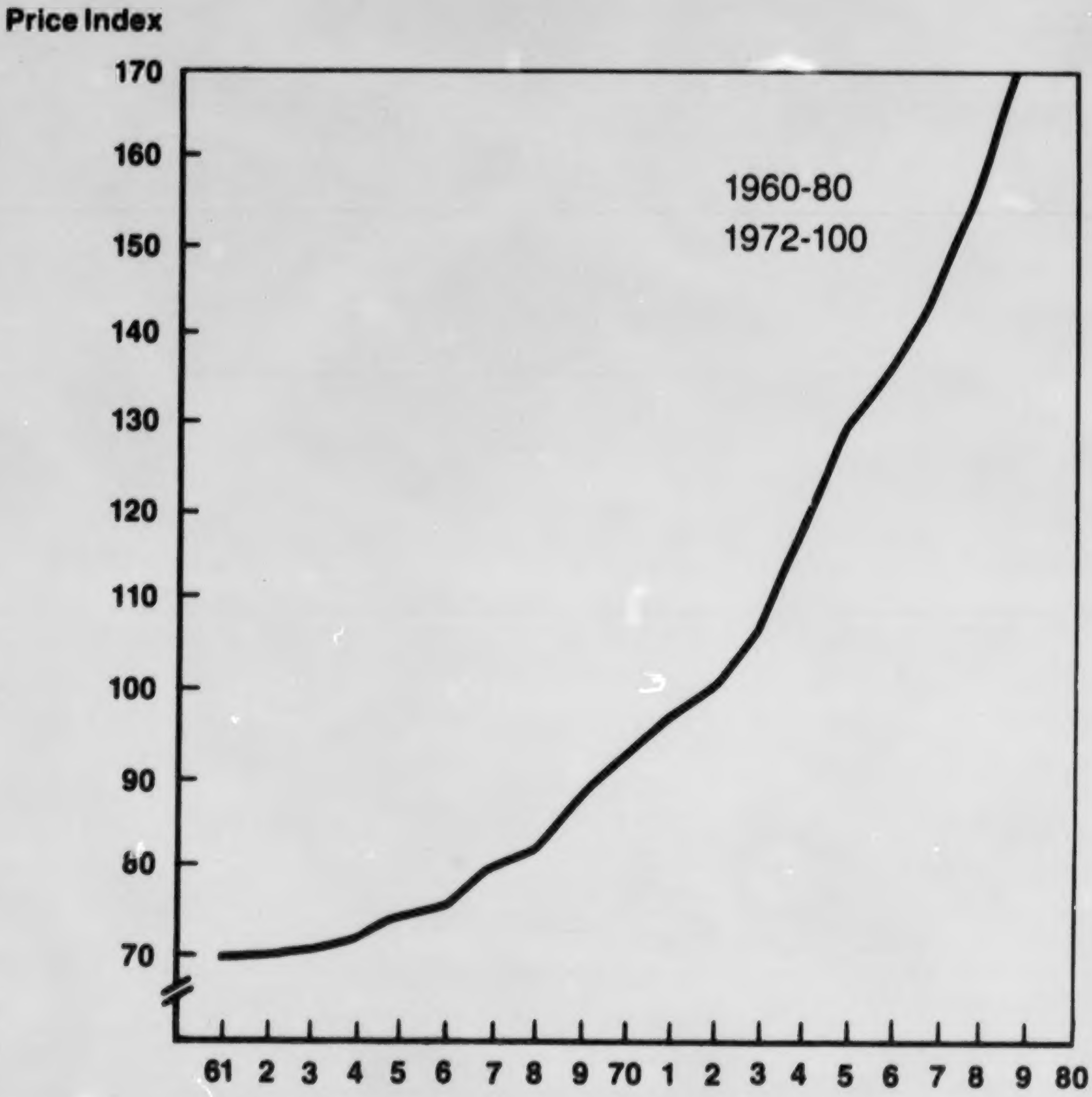
    c. The mean value for gallons used is 17.

    d. The mean value for gallons used is 28.

3. Would you use mean or median to convince the reader that students are large consumers of gasoline?

Student Worksheet

GRAPH I
CONSUMER PRICE INDEX IN THE UNITED STATES*

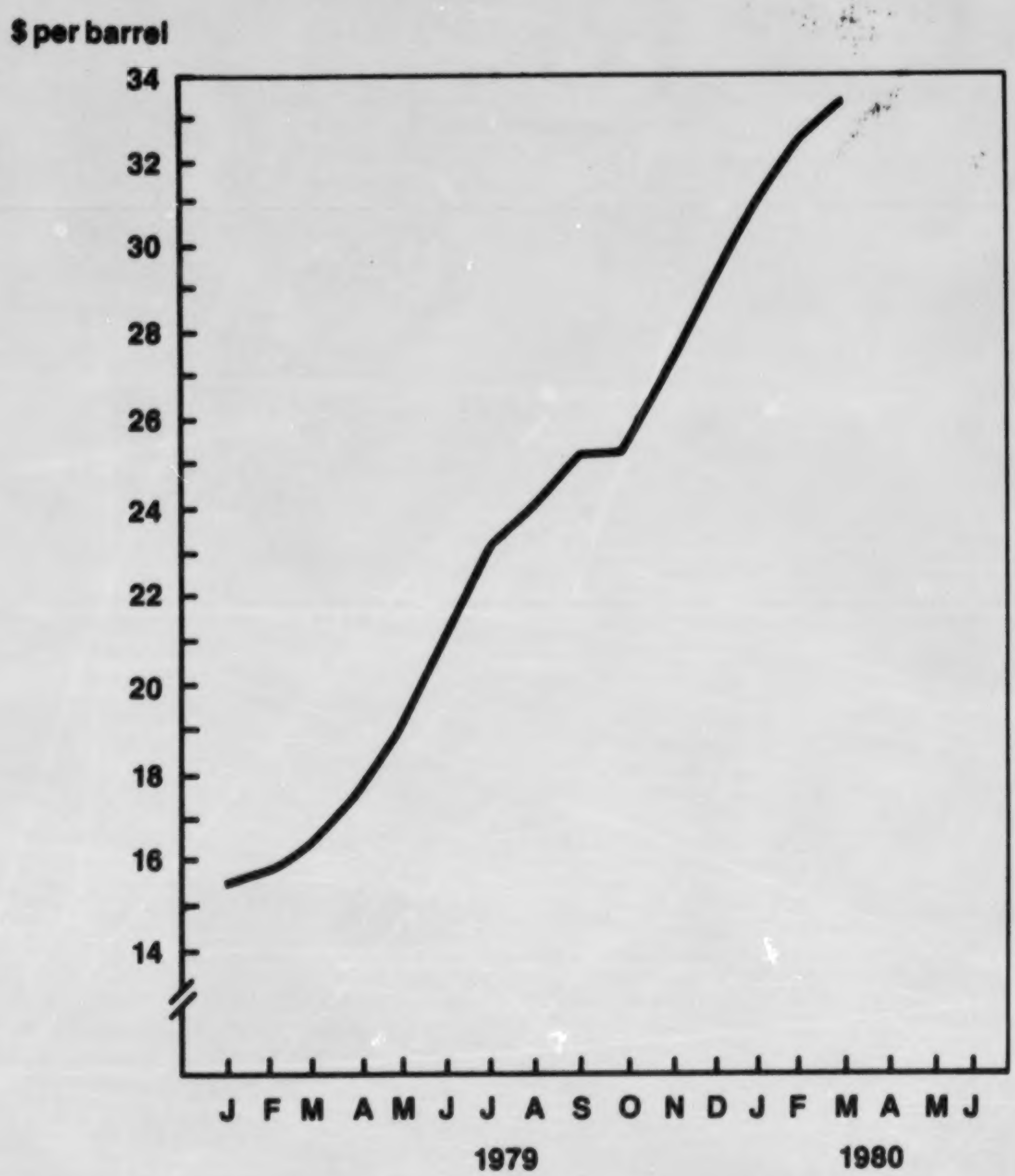


*The consumer price index is designed to show the month-to-month change in prices of goods and services bought by urban wage earners and clerical workers and their families. (Wall Street Journal 1972).

Source: Economic Report of the President. 1976.

Student Worksheet

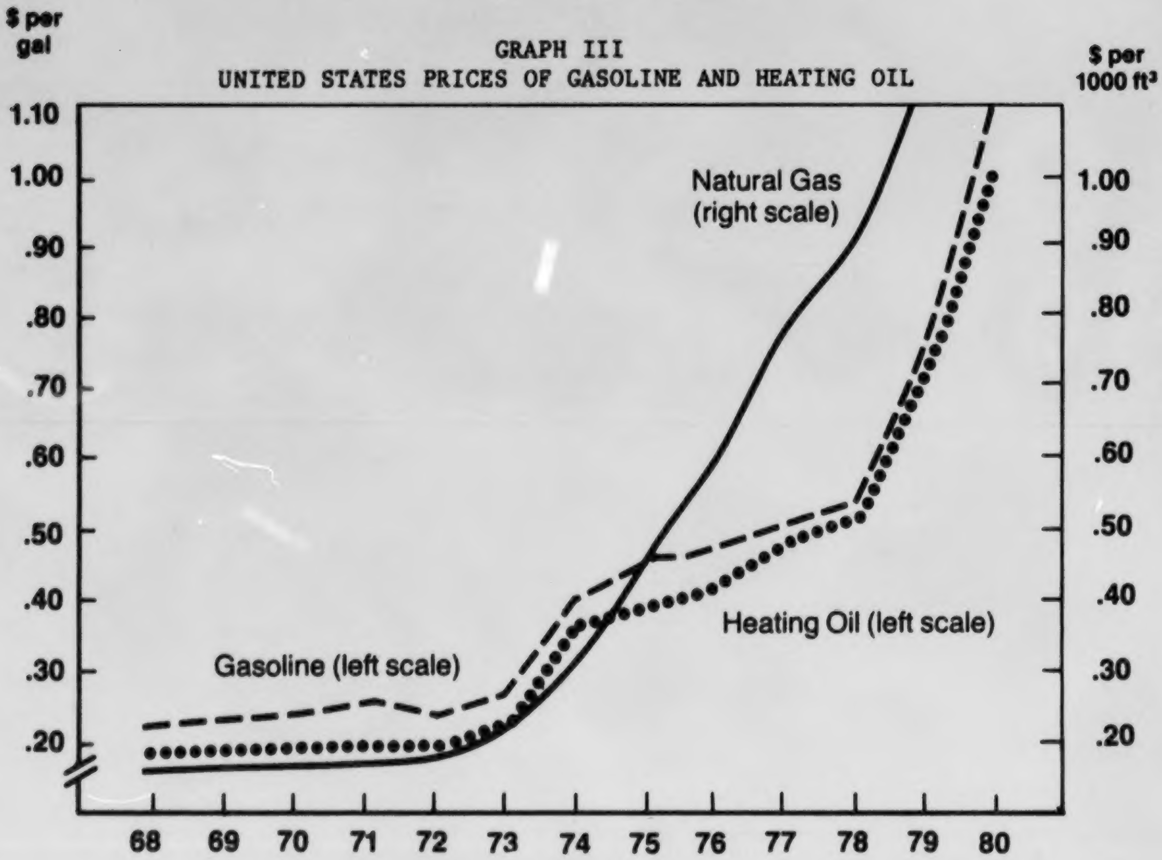
GRAPH II
IMPORTED CRUDE OIL PRICES
(January 1979 - March 1980)



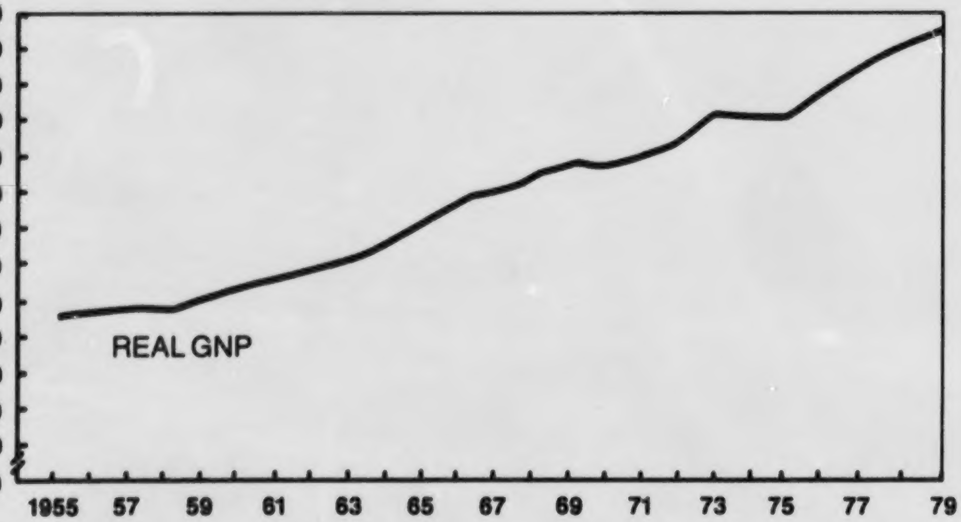
Source: Economic Report of the President. 1976.

Student Worksheet

GRAPH III
UNITED STATES PRICES OF GASOLINE AND HEATING OIL



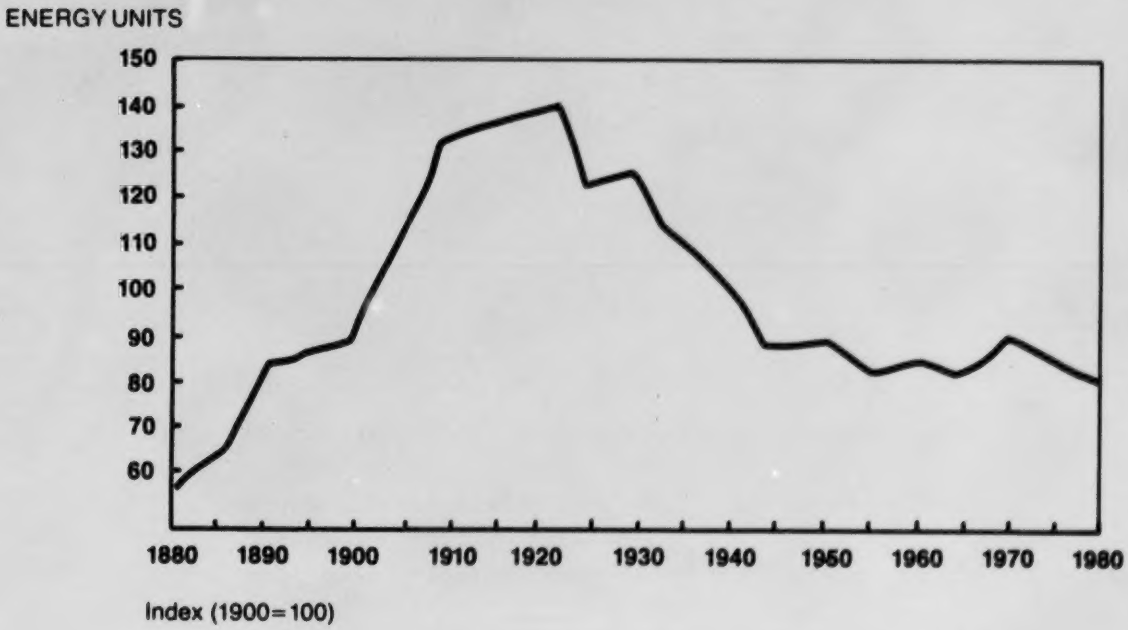
GRAPH IV
U.S. GNP IN CURRENT AND 1972 DOLLARS, 1955-79
(Billions of Dollars)



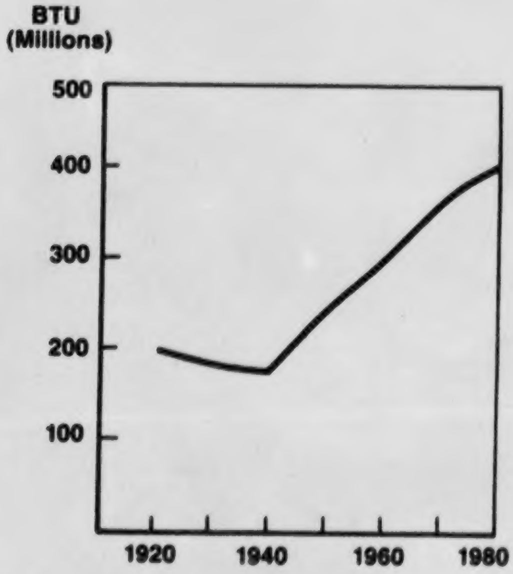
Source: Economic Report of The President, 1976

Student Worksheet

GRAPH V
INDEX OF ENERGY CONSUMPTION FOR A UNIT OF GROSS NATIONAL PRODUCT
UNITED STATES, 1880-1975



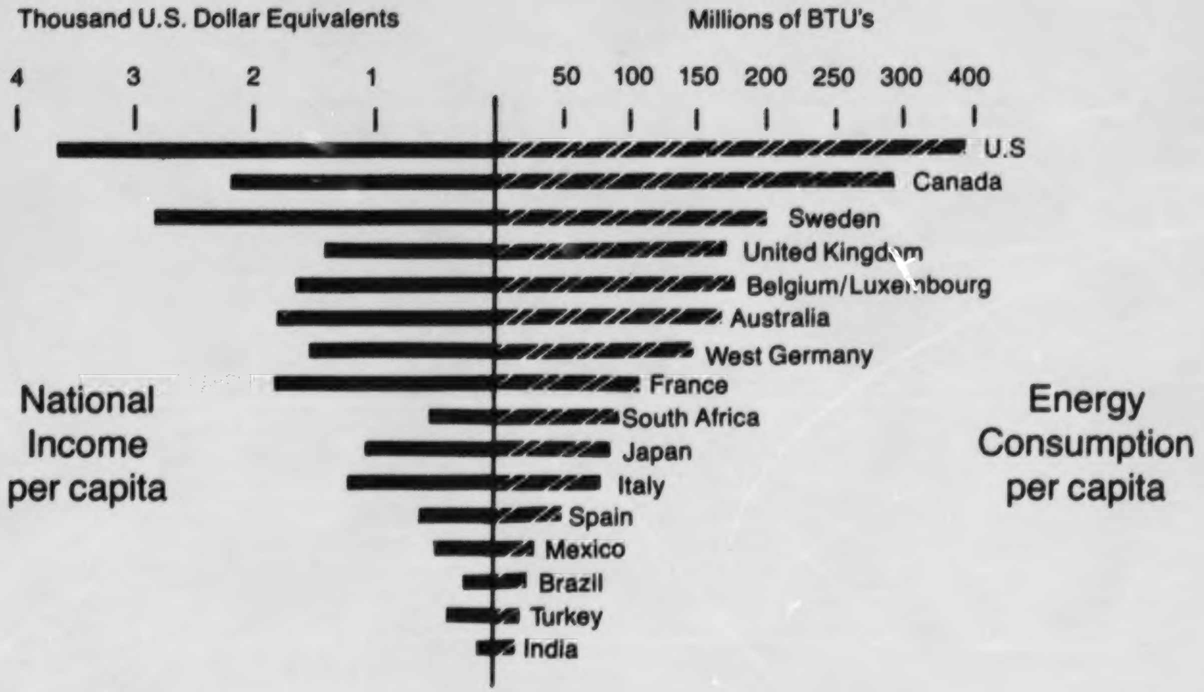
GRAPH VI
UNITED STATES ENERGY CONSUMPTION PER PERSON
1920-1980 (Projected)



Source: Resources for the Future Newsletter. Fall, 1975

Student Worksheet

GRAPH VII
NATIONAL PER CAPITA INCOME
AND ENERGY CONSUMPTION: 1968

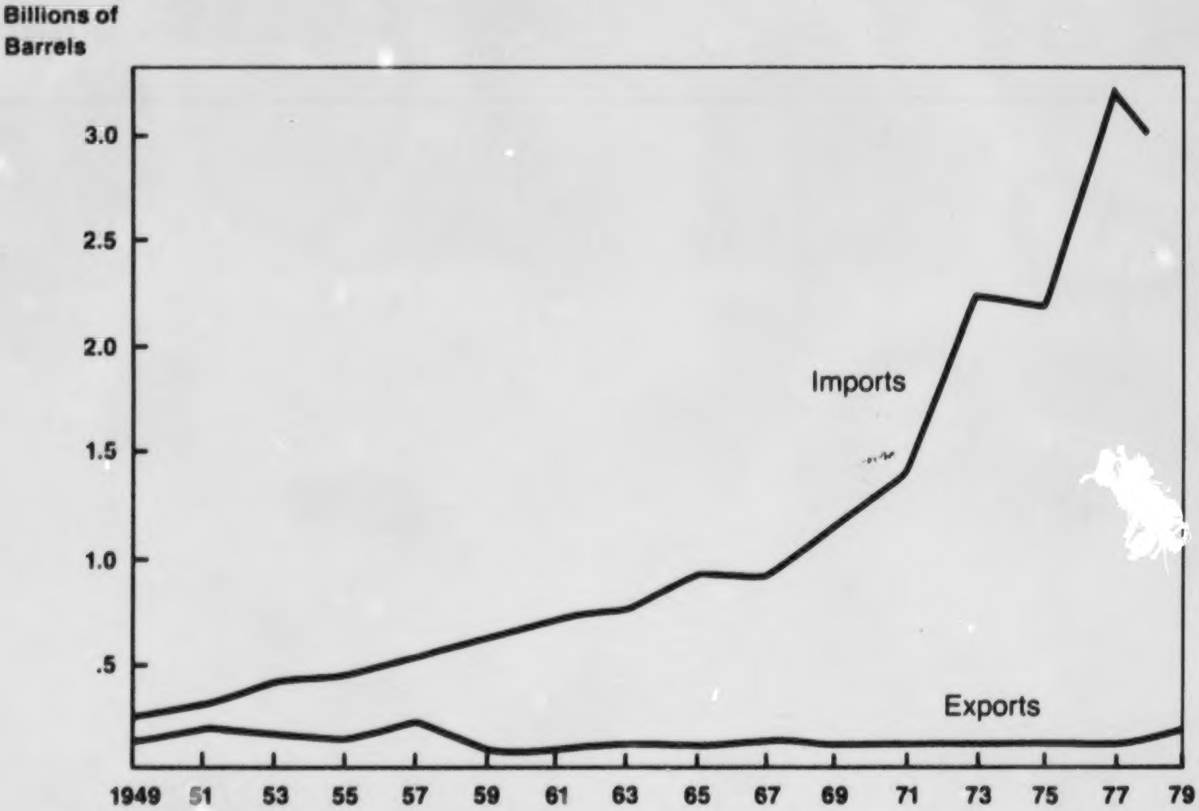


531

Source: Committee on Finance, United States Senate, Fiscal Policy and Energy Crisis. 1979

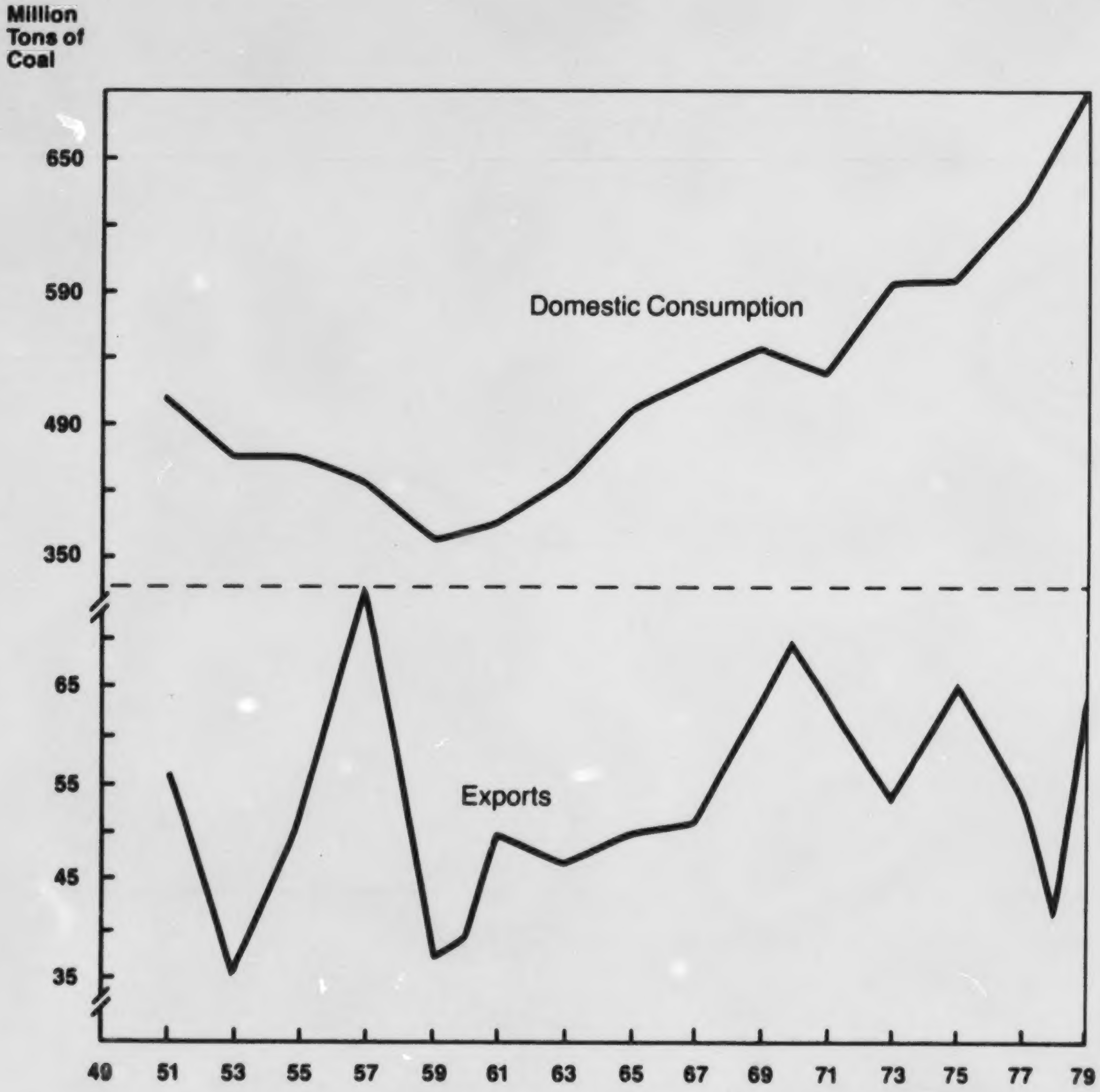
Student Worksheet

GRAPH VIII
UNITED STATES TRADE IN PETROLEUM



Source: Economic Report of the President. 1976.

GRAPH IX
UNITED STATES DOMESTIC CONSUMPTION
AND EXPORTS OF BITUMINOUS COAL



(Coal Imports are negligible)

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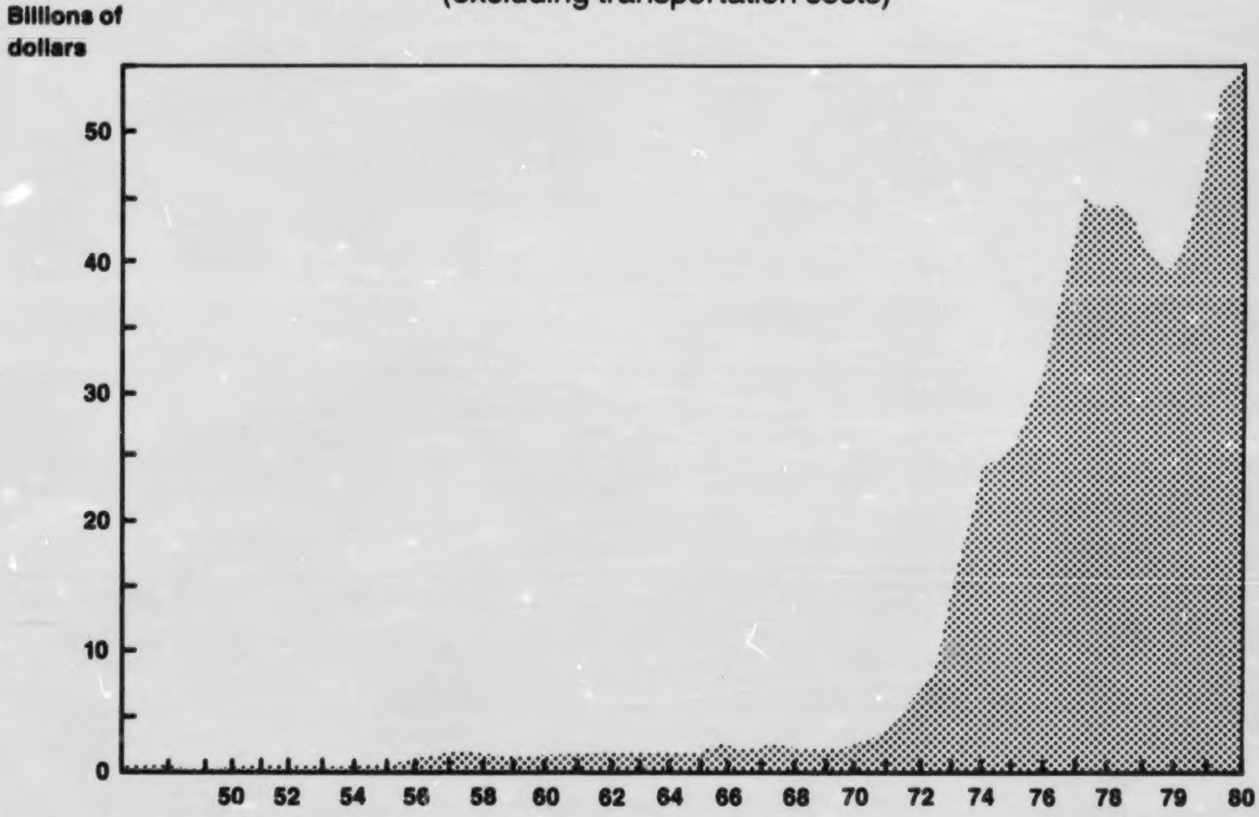
Source: United States Department of Energy. 1979.

Student Worksheet

GRAPH X

Year	Cost per Barrel	Total Cost
1972	$ 2.37	—
1973	4.08	$ 8.4 Billion
1974	12.52	26.5 Billion
1975	—	—
1976	13.48	34.6 Billion
1977	14.53	46.0 Billion
1978	14.57	56.0 Billion
1979	21.67	56.0 Billion
1980	32.14	

Cost of Oil Imports
(excluding transportation costs)

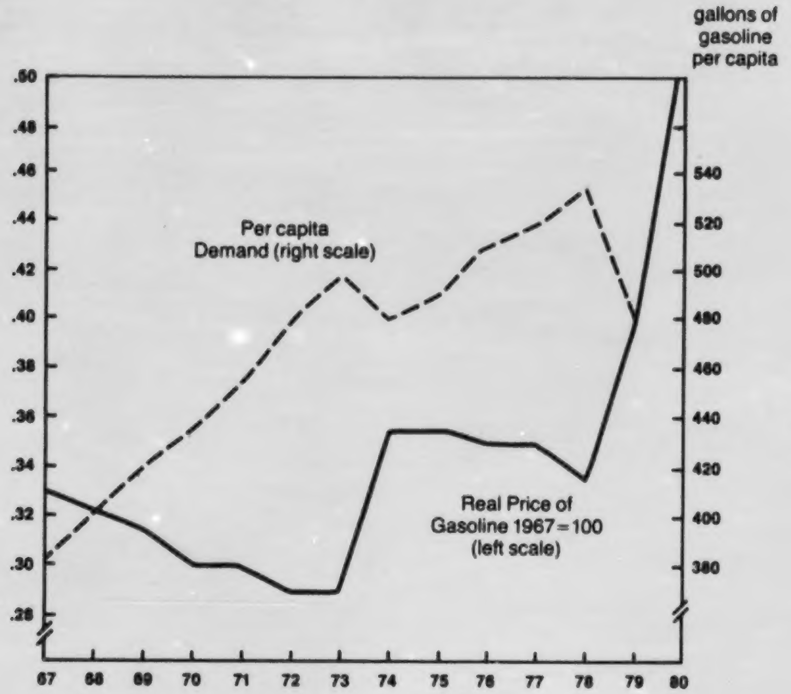


Cost of extracting Saudi Arabian oil averages 12¢ per barrel.

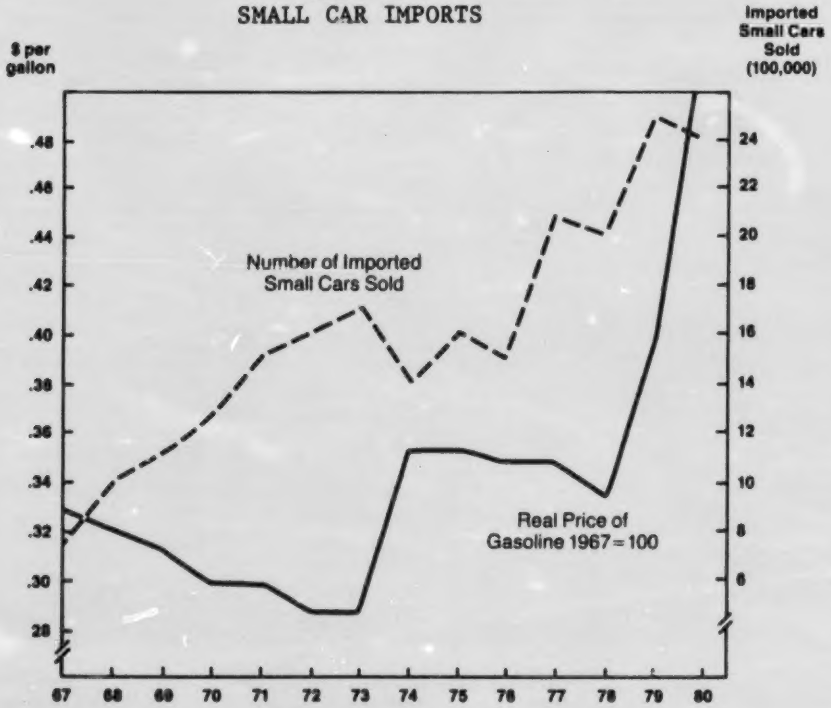
Source: United States Department of Energy, 1979

Student Worksheet

GRAPH XI
REAL PRICE OF GASOLINE AND PER CAPITA DEMAND



GRAPH XII
SMALL CAR IMPORTS



Source: United States Department of Energy. 1979.

SOME POSSIBLE GENERALIZATIONS

Graphs

I. The Consumer Price Index has risen from 1955 to 1975. The largest
II. price increases have come from 1973 to 1979. Gasoline, heating oil,
III. and natural gas prices climbed drastically in 1978 and 1979. The
price of imported crude oil increased at the same time.

IV. U.S. GNP measured in 1972 dollars increased from 1955 to 1979.
V. Energy consumption per unit of GNP rose from 1880 to 1925.
Energy consumption per unit of GNP fell from 1925 to 1975 with the
exception of 1968 to 1970.

VI. Energy consumption per person increased from 1940 until the present.
VII. The sharpest increase occurred from 1948 to 1972. The average U.S.
citizen uses much more energy than any other national group. Industrialized countries like the U.S., Russia and Germany use more energy per person than do non-industrialized nations.

Sweden has a higher income but a lower energy consumption than Germany.

Poorer countries use less energy than rich countries.

VIII. U.S. imports of petroleum have increased overall from 1949 to 1977,
IX. with a noticeable sharp decline in 1977. Petroleum exports have re-
X. mained fairly constant in the period from 1949 to 1979. The domestic
consumption of coal has increased overall from 1957 to 1979 with a sharp increase in the period of 1977 to 1979. At the same time the exports of coal have experienced very erratic behavior, with a decline from 1975 to 1978.

The cost of oil imports remains steady from 1950 to 1970 and then they experience very sharp and dramatic increases. The cost of imported oil per barrel has increased from $2.37 in 1972, to $32.14 in 1980. The cost of oil imports has had a dramatic increase from 1979 to 1980. The U.S. paid 8.4 billion dollars to buy foreign oil in 1972 and 56 billion dollars to buy foreign oil in 1979.

XI. The real price of gasoline showed a dramatic increase in 1973 and
XII. again in 1978. The per capita demand for gasoline, while increasing
in general from 1967 to 1980, showed a dramatic decrease in the same years that the real price of gasoline increased, which were 1973 and 1978. The number of imported small cars has increased from 1967 to 1979, the steepest increase coming from 1977 to 1979. The number of imported small cars decreased over the same years that the real price of gasoline remained fairly constant, 1974 to 1977.

LESSON #43

CATEGORY: Conservation

ENERGY TYPE: All

TITLE: Life-Cycle Cost Be Misleading

GRADE LEVEL: 9-12

TIME NEEDED: One period

INFUSE WITH SUBJECT AREA:
Social Studies
Home Economics
Consumer Education
Math

MATERIALS:
None

OBJECTIVES:

1. The students will understand the concept of life-cycle cost.
2. The students will demonstrate their understanding of the concept by making consumer judgements based on calculations of life-cycle cost.

TASK ANALYSIS:

The students should be able to do basic math computations and follow written instructions.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheet 43.4
   Read Teacher Background Information (43.3).

2. Steps in Lesson
   Objective #1: The students will understand the concept of life-cycle cost.

   a. Discuss formula for calculating gasoline cost per year:
      mpy ÷ mpg = gpy   gpy x cpg = cpy

      Miles per year divided by miles per gallon = gallons per year. Gallons per year multiplied by cost per gallon = cost per year. Cost is for fuel only; does not include maintenance, insurance, repairs, license, financing, etc.
   b. Discuss idea of things and systems having "lifetimes." How long does a car last? An appliance?

   Objective #2: The students will demonstrate their understanding of the concept by making consumer judgements based on calculations of life-cycle cost.

This lesson was written by Carol Gaddy.

Ask students to do a quick life-cycle cost comparison (as in the Teacher Background Information) of two or more cars they would like to own. Do they know the mpg's? How many miles per year do they think they drive? (Average for U.S. = 12,000, average for Arkansas = 14,000.) Would they buy the most fuel efficient? Why? Why not? What other considerations would affect their decision besides fuel efficiency, operating cost, pay-back period? (color, style, engine, performance, monthly payments, availability of financing, etc.)

3. Evaluation

Distribute Student Worksheet 43.4 and have students complete. Correct and discuss.

4. Follow-Up Activities

These activities are not sequential and are optional. The Arkanasas Energy Office has sent a copy of the Arkansas Energy Saving Handbook for Homeowners by James W. Morrison to all libraries including your school's. If the library does not have it, call the Energy Office Hotline: 1-800-482-1122. There is no charge. You may copy anything in the handbook for student worksheets.

a. Have students look up the Arkansas Energy Saving Handbook for Homeowners in the school library and calculate the pay-back period on insulating their own home to the R-factors suggested in the Handbook.

b. Have students read the section in the Handbook on solar hot-water systems. Discuss why solar advocates claim solar hot water systems are now cost competitive with conventional systems (natural gas, electric) when one considers life-cycle cost. Why are solar hot-water systems likely to become even more cost effective? (As conventional fuel costs rise, particularly after deregulation, the minimal operating costs of solar systems become an even greater advantage and the pay-back time even shorter.)

TEACHER BACKGROUND INFORMATION

When energy was cheap and plentiful no one worried much about whether he/she could afford to heat their house or drive the cars or operate the appliances or fuel the power plants. Now the cost of the fossil fuel energy on which we have depended so heavily has skyrocketed and is expected to continue to rise.

Now the cost of energy, of gasoline to operate a car or natural gas to heat a house, may be more than the monthly payment on the car or house itself. When power plants use fossil fuels to generate electricity their costs go up, too, and they pass those costs on to consumers whose appliances, lights and air conditioning become more expensive to use.

What can consumers do to cope with these rising costs? They may try buying more energy efficient machines; a car that gets better mileage, for instance, or an appliance or air conditioner that is advertised as energy saving. But what if the more efficient machine or appliance costs more to buy? They may try insulating the house, and putting in storm windows and doors to be more energy efficient but that costs money and how can they afford to spend more than they are already paying?

The power company has to generate electricity for all those lights and appliances and air conditioners. They may even have to build a new power plant to take care of the demand and that will take a big investment of capital.

In all these situations, the decision will be easier if life-cycle cost is taken into account. The principal is simple: how much will a given item or system cost to operate over its lifetime? Compare that to the cost on continuing with the present system over its lifetime or compare the life-time operating costs of alternate systems.

A difference in purchase price may be recovered over time by lower operating costs. The length of time it takes to do that is called the pay-back period.

A car gets 15 mpg and is driven 15,000 miles per year, at $1.50 per gallon, will cost $1,500.00 in gasoline annually; if gasoline prices go up to $2.00 per gallon, that total goes to $2,000.00.

Another car gets 30 mpg and is driven 15,000 miles per year. At $1.50 per gallon, the annual cost for gasoline is $750.00; at $2.00 per gallon, the figure is $1,000.00.

Changing to the 30 mpg car will save $750.00 — $1,000.00 per year, depending on the price of gasoline. Over the lifetime of the vehicle -- say 10 years -- that would amount to $7,500.00 - $10,000.00. Even in 5 years' time the savings would be $3,750.00 - $5,000.00

If the purchase price of the 15 mpg car is $6,000.00 and the 30 mpg car is $7,500.00, the difference is $1,500.00. With gasoline at $1.50 per gallon, that is a 2 year pay-back (pay-off) period. With gasoline at $2.00 per gallon, the pay-back period is 15 months on the extra investment in energy efficiency.

Similarly, appliances with a high Energy Efficiency Ratio (look for the EER labels), while they may be more expensive, will usually pay for themselves in lower operating costs.

Student Worksheet

LIFE-CYCLE COST

1. You need a new refrigerator. You find two that have the features you want; one has an Estimated Yearly Operating Cost (EYOC) of $50.00 and costs $400.00 The other has an EYOC of only $25.00 but costs $450.00.

   a. Which model should you buy?

   b. What is the pay-back period if you buy the more expensive model?

   c. If the estimated life time of both appliances is 15 years, compare their operating costs over their life-cycle.

2. According to a report by the Arkansas Energy Office, an engineering firm has completed a study of the feasibility of restoring the hydroelectric generating plant at Mammoth Spring State Park to operation. The plant, built in 1925, has a generating capacity of 350 kw. This is enough electricity to power 500 energy-efficient households or one moderately large hospital.

   The cost of restoring the plant, which was abandoned by ARKMO Power in 1972, is estimated to be between $500,000 and $950,000. The electricity produced by the plant would be worth $80,000 in its first year of operating, and would be worth more in succeeding years as energy costs continue their upward spiral. The rehabilitated plant is expected to produce power for at least another fifty years.

   a. Would you recommend putting this plant back into operation?

   b. How much would the electricity this plant could produce in its lifetime be worth, at the present rates?

   c. Is that value likely to increase?

   d. How long would it take to pay back the investment in restoration?

   e. What will the fuel costs to be run this plant?

Student Worksheet

LIFE-CYCLE COST
ANSWER SHEET

1. a. The \$450.00 model

   b. Two years (\$450.00 - \$400.00 = \$50.00; \$25.00/year savings).

   c. \$375.00 compared to \$750.00.

2. a. Yes

   b. \$4,000,000

   c. Yes (inflation; higher fuel costs; higher electric rates)

   d. 6 - 12 years $\frac{500{,}000 \text{ or } 950{,}000}{80{,}000}$

   e. Nothing (There will be operating and maintenance costs, but the "fuel" is water/gravity.)

LESSON #44

CATEGORY: Conservation

ENERGY TYPE: All

TITLE: Critical Reading Skills

GRADE LEVEL: 10-12

INFUSE WITH SUBJECT AREA:
Language Arts

TIME NEEDED: Six periods

MATERIALS:
Magazines and newspapers

OBJECTIVES:

1. The students will distinguish fact from opinion in energy statements.
2. The students will be able to classify energy advertisements by propaganda techniques used.
3. The students will recognized "loaded" words as a technique used to influence opinion.
4. The students will write and evaluate energy-related television advertisements.

TASK ANALYSIS:

The students should have language skills such as knowing parts of speech; be able to read and comprehend newspaper articles and editorials, and have auditory abilities to understand speeches and commercials on radio and television.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 44.6 - 44.11; 44.21 - 44.22.
   Cut out Product Cards (44.12 - 44.16) and Target Audience Cards (44.17 - 44.20); these may be mounted on tag board to extend the length of their life and use.
   Collect magazines and newspapers for students to clip if they do not have access to these print materials at home.

2. Steps in Lesson
   Objective #1: The students will distinguish fact from opinion in energy statements.

   a. Students independently answer F (fact) or O (opinion) as directed on Student Worksheet 44.6.
   b. Discuss in class the students' answers. There is much learning gained from this discussion as many answers can be qualified and show opinion rather than fact and vice versa. The student discussion will demonstrate to students that the opinions we hold affect the way we read statements. Ignorance of facts make some readers accept flat statement as being accurate, whereas some readers discount every statement unless it is verified with a reliable source and date.
   c. (Optional) Ask students to change each statement to the opposite rating, i.e. change opinions to facts and vice versa.

This lesson was written by Helen Holmes based on materials from National Science Teachers Association and from Dr. Jerry Long, Arkansas State University.

Objective #2: The students will be able to classify energy advertisements by propaganda techniques used.

a. Have students collect ads about energy from newspapers or magazines. Each student is to collect five ads from such companies as the following examples; utilities, oil companies, electric or gas appliances if energy is mentioned, etc.
b. Using Student Worksheet 44.7 as information, students should classify each ad giving the propaganda label which best fits that ad. Sub-classifications (other propaganda techniques in the ad may be listed) under the main one.

Objective #3: The students will recognize "loaded" words as a technique used to influence opinion.

a. Have students complete worksheets 44.8 and 44.9 independently or in pairs.
b. Class discussion follows which focuses on the students' answers to the worksheets. Ask students to give other examples of loaded words they have seen or heard used (in ads, editorials, speeches, etc.).
c. Assign students to bring to class the next session an example of loaded words which they find used in printed materials. Display these materials on a bulletin board along with students' coding or comments attached explaining the techniques used to bias the readers.
d. Have students bring to class a short newspaper article on an energy-related topic. You might prefer to make this a group activity for small groups, since it does generate enthusiasm when done cooperatively. Give the following instructions to the students:

> You are to rewrite the article in a way that will present a particular point of view. Then read your revision aloud to the class.
> You are then to evaluate the re-written articles using the following questions:
> -What point of view does the article have?
> -Is it sympathetic or unsympathetic to the subject of the report?
> -What words or terms were used to arouse sympathy or to discredit the subject?
> -Did you agree or disagree with the point of view? Why or why not?

Objective #4: The students will write and evaluate energy-related television advertisements.

a. To introduce the simulation on advertising, the teacher can ask the students to name TV advertisements they like and dislike and state the reason why they hold these opinions. Hold a general discussion about what kinds of advertisements influence them, what kinds they dislike and what kinds they just do not pay any attention to in addition to what media these advertisements utilize.

   Begin to focus the discussion around television and its particular ability to use not only words and music but also visual action to sell a product or service. Then, introduce this activity to the students as a very realistic simulation on television advertisement writing and inform them that by participating in this simulation, they will become more aware of how products are advertised and how to become more effective consumers.

b. Team Formation

Divide the class into groups of four or five students and announce that each group is an advertising company which has just received a contract to develop an advertisement for a new energy-related product. The advertisement, if accepted by an evaluation panel, will be produced on television. The consumer evaluation panel will furnish information by filling out an evaluation form on how favorably the product was presented through the television advertisement.

-Allow 30-45 minutes. Cut out and have ready the Product Cards and Target Audience Cards (44.12 - 44.20). Distribute Writing Team Task Cards (44.10) (one to each team) and Television Script Format Sheets (44.11) (10 or more to each team).

-Place the ten Product Cards (44.12 - 44.16) and the ten Target Audience Cards (44.17 - 44.20) face down on a desk or table and shuffle each of the piles. Have each writing team send one student to the table and draw one card from each pile. These cards supply the information needed for the team to develop the television advertisement. Caution each team not to let the other teams know what information is on their cards. Explain that this will be the task of the consumer evaluation panel and each one of them will have the opportunity to serve on one or more consumer evaluation panels.

-Announce that each team will have thirty minutes to write the script (audio) and actions (video) and copy it on the Television Script Format to be handed in to the Advertisement Supervisor (teacher). At this time the Writing Team members may begin their task.

-The teacher should act as the Advertisement Supervisor and answer technical questions as they occur. The Advertisement Supervisor should also keep track of time and inform the teams of how much time is remaining in the writing period.

-After twenty-five minutes of the writing period has elasped, the Advertisement Supervisor announces that the teams have five minutes to complete their advertisements and copy them in final form on the Television Script Format Sheet. When this five minute period is over, the Advertising Supervisor calls for the advertisements.

c. Presentation of the Advertisement to the Consumer Evaluation Panel. Distribute Advertising Evaluation Sheets I and II (44.21 and 44.22). Each student will need enough of Evaluation I to score each team's advertisement except his/her own team. At this point, two options for presenting the advertisements exist:

-A representative of each writing team can read his/her advertisement and members of other writing teams can serve on the Consumer Evaluation Panel.

-The second option is to allow the writing teams to bring costumes and props from home to class and dramatize their commercial as it would appear on television. This second option is far more realistic and should be selected if at all possible. It is recommended that all teams choose the same option in order to provide consistency in the consumer evaluation.

At this time decide on a performance sequence for the writing teams.

Each team has five minutes to present its advertisement. At the end of each presentation, have the students on the Consumer Evaluation Panel complete an evaluation sheet Part I and hand it to the Advertisement Supervisor. Give each student a new Part I for each advertisement.

When all the presentations are complete, have the writing teams tally the totals for the questions and put the information on the chalkboard.

d. Begin the debriefing or analysis of the activity by inspecting the data placed on the chalkboard by each writing team. Use the following procedure:

-Compare and contrast the data on product, target population and television show. Did one or more teams do an outstanding job of communication?

-Compare and contrast the students' perceptions of product strengths and weaknesses. Were they presented in a balanced, honest method or did the teams tend to maximize the strengths and minimize the weaknesses of a product?

-Compare and contrast the answers to the other questions with the students' decision to buy or not to buy a product. Is there any relationship?

-Develop, with the students, some guidelines for evaluating advertisements. These should include recognizing when you are a "target", weighing strengths and weaknesses of a product, how to obtain more facts and other opinions on a product, and how to avoid impulse buying until you have gained this information. Refer the students to the "facts" section on each product card. Point out that this is the information which is most important to the consumer. Summarize by saying that during this period of change in our energy supply/use patterns, there will be large numbers of new and untried products and services entering the marketplace. The ones used in the simulation are typical. It will be the consumers' job to obtain the factual information to determine if a particular product is beneficial to them.

3. Evaluation

Teachers may assess student learning through their participation in the discussion and by the completion of Worksheets.

4. Follow-Up Activities

a. The debriefing in the lesson conclusion raises the point that the consumer is responsible for weighing the advantages and disadvantages for products and services and obtaining the real facts. During the past decade, consumer groups, consumer magazines, legislation, and local business agencies have begun to focus on assisting consumers to obtain factual information. To extend the lesson, have students locate sources of information in the following areas:

Publications -- What consumer publications are available and what type of information do they provide to the consumer?

Legislation -- What federal and state legislation exists to protect the consumer?

Organizations -- What local, state, and national groups exist to protect the rights of consumers?

Local businesses -- What local organizations or bureaus exist and what services do they provide to protect the consumer?

Students may bring their information back to the classroom to share and, if desirable, resource persons from local credit unions, consumer groups, government and groups with an energy bias such as environmentalists or utilities can be invited to speak on their specialities.

b. Packaging an item and noting energy used in making, marketing and destroying the package.

The purpose of this activity is to give the student practice in using visual as well as word imagery to sell a common item. It is suggested that the students work in teams of two. You will need an item for each team, and all teams should package identical items. The criteria for the item are that it is small enough to package easily and is so common that it has no particular appeal by itself. Some common items you might want to consider are books, pencils, a glass of water, eggs, a box of paper clips. The assignment should be made at least a day in advance so that the students have time to collect the materials they wish to use in packaging and promoting the item.

After the class makes a choice, ask them to analyze its appeal. Some of the criteria might be:

-aesthetic appeal (color, design, shape)
-choice of words
-who made it and how it was presented
-appropriateness of target audience
-illusion of size
-can the package be reused or recycled

Compare the energy intensiveness of the package. Was this a consideration in the packaging or choice?

Student Worksheet

EVALUATING SOURCES -- FACT AND OPINION

FACT: A fact is something one can prove to exist or to have happened; an actual occurrence.

OPINION: An opinion is a belief, view, or judgement which might be subject to dispute.

When doing research it is important to remember that all of your sources might not treat the same subject matter in the same way. If you were doing a study on the energy situation in Arkansas you could expect different viewpoints depending on who you talked to. For example, what would you expect to hear from an oil company official as compared to an environmentalist. Many authors write the opinion of what they think happened. Their opinion is usually based on researching the facts surrounding the event.

EXERCISE: In the following blanks, place an F before a statement of fact, and an O before an opinion.

1. _____Solar energy is the only answer to the energy crisis.
2. _____There is an energy crisis.
3. _____The oil companies caused the energy crisis.
4. _____Energy costs have increased to the consumer since 1973.
5. _____Oil Producing Export Countries (OPEC) charge the United States too much money for oil.
6. _____Fifteen inches of blown fiberglass insulation gives an R value of 33.
7. _____Once energy is used, it is recycled.
8. _____Florescent light bulbs use less energy than incandescent light bulbs.
9. _____Eight-cylinder cars should be banned from the highways because they consume too much gasoline.
10. _____Americans should become energy conscious because the supply of fossil fuels on earth will some day be used up.

Be prepared to defend your answers in class discussion.

Student Worksheet

PROPAGANDA

This activity asks you to identify the different kinds of propaganda seen in magazine or newspaper ads and TV commercials. Find one ad or commercial that fits in the following categories:

1. Bad Names and glad names. Bad names encourage the consumer to judge the competitors' products without looking at the facts. An ad that says "Better than the high-priced spread" is an example of bad-name propaganda. Glad -name ads use such words as charming, lovely, beautiful, highest grade, etc. These words don't tell you anything concrete about the product; they just say, "like it."

2. Transfer. The idea of transfer is to have us think about something we like while we're thinking about a particular product. If a fabric softener is said to make your clothes "baby soft," then you think about babies. If you feel good about babies, you probably have a good feeling about the product.

3. Testimonial. This is one of the easiest forms of propaganda to spot. A famous personality says, "I like this product. I use it all the time and it's great." Because we like or respect the personality, we may try the product.

4. Bandwagon. Have you ever said to your parents, "But everyone else is doing it, why can't I." Or "Everyone else is going." This is bandwagon propaganda. Ads that say things like "Nine out of ten people" or "millions of Americans" or "the most used brand in America" are using the bandwagon approach.

5. Plain folks. Picture a happy family going to a drive-in restaurant for dinner. The restaurant is a family eating place, for plain folks like you and me.

6. Stacking the cards. Car manufacturer X says "our car rides smoother than a $20,000 limousine" and implies that the $20,000 limousine isn't worth the money, which may be true, but the ad doesn't offer any facts to back up the claim. They are telling you a lot of "facts" and hoping that you'll think they are more special than they really are. One of the characteristics of this form of propaganda is half truths masquerading as whole truths.

For each ad or commercial that you find, write three sentences describing what type of propaganda is being used. Remember that one ad or commercial may be using several types of propaganda.

Is there such a thing as good propaganda? Find or quote two examples of good propaganda. (Example: informing about the safety or energy efficiency of a product.)

Student Worksheet

EVALUATING SOURCES -- LOADED WORDS

LOADED WORDS: Loaded words, often with an emotional appeal, are a means of influencing the reader in some direction. Many people who write newspaper articles, letters to the editor, advertisements, political speeches, magazine articles, and textbooks choose certain words to try to influence one's attitude toward a person, event, or situation. In doing this, the author usually chooses certain words which will affect our opinion. This does not mean that the author is printing false facts or lies. It means that the author may be trying to shape our attitude.

EXERCISE: "The pro-energy candidate was seen striding into the room."

"The pro-energy candidate was seen walking into the room."

What is the "loaded" word? ______________ How does it change the meaning of the sentence and affect your opinion of the candidate?

Compare these two headlines concerning the same event:

WHITE HOUSE PICKETED BY 12,000 IN NOISY PROTEST OF ENERGY WASTE

ENERGY CONSERVATIONISTS PARADE IN D.C. & NOTHING MUCH HAPPENS

Which are the "loaded" words? Could they influence your opinion?

Compare these two examples:

> "The candidates were Bryan Wilson, president of American Oil and Florence Greenwood, a pert, blond, grandmother of five and a supporter of ERA and well known advocate of energy conservation."

> "The candidates were Bryan Wilson, president of American Oil, and Florence Greenwood, a housewife.

Neither statement is false. One of the above statements can influence your opinion more than the other. Which statement is more fair to Florence Greenwood? If you were in favor of Bryan Wilson to win the election, which statement would you print in the newspaper?

Student Worksheet

AMERICANS ARE THE MOST GLUTTONOUS ENERGY CONSUMERS IN THE WORLD

Adapted From an Article by Dorothy K. Newman
in the Arkansas Gazette, 1980

Americans are the world's most gluttonous energy consumers. With about five percent of the world's population, we gobble up a third of all energy used in the world.

Americans, who use the most energy, are unwilling to make voluntary sacrifices for conservation. Conservation has been effective only when backed by law. We use four times as much indirect energy to maintain our lifestyle.

For instance, clothing involves energy costs in making the fabric, and designing, sewing and shipping the garment. If one charges it instead of paying cash, the costs in billing machines usage, paper, and postage must be added.

The people with more money than they know what to do with have many more electricial appliances than lower-income households, including such large energy-intensive kinds as frost-free refrigerators, color TV's and self-cleaning ovens.

In contrast, most low-income households who work hard for their money live in small homes or apartments with one bath. Many have only a black and white TV, their refrigerators are not automatically defrosted, their ovens are hand-cleaned, and they are usually without air conditioning.

CODE: Mark an X above words or phrases that are loaded words; O above words or phrases that are opinions and F above phrases that are fact. Be prepared to tell why they seem to be opinions.

550

Student Worksheet

WRITING TEAM TASK CARD

Task: Your advertising company has thirty minutes to design and write a 150 to 200 word (about the number of words on one written page) television advertisement based upon the information on the three cards your team has drawn. Your task is to design an advertisement which will sell the product to the target audience watching a particular program.

Guidelines and Rules: Your team must mention both the strengths and the weaknesses of your product within the advertisement. How you do this is your own decision. You must decide whether to use a straight factual approach or a statistical or psychological play which emphasizes your product's strengths and minimizes its weaknesses. The advertisement must be aimed at the specific target audience listed on your cards. Marketing research has shown that a specific group will be more likely to purchase a product or service if approached properly. Write your advertisement specifically for the target audience.

Television is a visual medium and your team's actions may be as important as your words. Draft your advertisement with both visual and audible actions in mind. When you copy your advertisement on the Television Script Format Sheet, you will list the actions (video) in the left column and the words (audio) that correspond to the actions in the right column. This is standard television script procedure.

Caution: The advertising business is very competitive. For security reasons, do not share any of the information on your cards or any ideas about your advertisement with any members of the other writing teams. In the end, all members of all teams will have an opportunity to comment on the advertisements.

Student Worksheet

TELEVISION SCRIPT FORMAT SHEET

Copy your final advertisement on this sheet. Use the left column to describe any actions by the character or characters and the right column for the accompanying words.

VIDEO	AUDIO

Student Worksheet

PRODUCT CARDS

MASS TRANSIT RIDERSHIP

Develop a television advertisement whose goal is to increase the rider density on a middle sized urban mass transit system. While the bus system has been in operation for several years it has a low appeal public image. Recent bond issues have resulted in upgrading the service and the transit board needs to increase the ridership to make the system cost effective.

ADVANTAGES

1. There are real benefits to the community in that if a 20-30 percent increase in ridership is achieved, the mass transit system can become self-sustaining and pay its own maintenance and administration costs.
2. The overall fuel consumption of the community will stabilize or decrease based upon higher passenger density in the mass transit system.

DISADVANTAGES

1. Mass transit riders have limited flexibility. Except for rush hours, buses run only once per hour with limited routes on Saturday and Sunday.
2. Round trip tickets cost $1.00 per day which is not competitive with four person car pools.

FACT

The transit system is probably economical and convenient for day workers in the downtown area. However, the inconvenience and cost detract from mass transit as a primary transport for all citizens.

COMPACT CAR

A major automobile manufacturer is announcing the introduction of a new compact car which has been designed to achieve high gasoline mileage. The vehicle is of the "shoe" design with the capacity to hold four people in a very small volume. Your job is to name the vehicle and write an advertisement.

ADVANTAGES

1. This car achieves mileages in the top one percent of all vehicles. (Over 40 miles per gallon).
2. With four riders, this vehicle offers the lowest cost per mile of all vehicular transport systems.
3. Easy to park in congested areas.

DISADVANTAGES

1. With four riders, this car offers no creature comfort and long trips are very uncomfortable.
2. This car has little or no acceleration when carrying at full capacity.

FACT

While offering real savings in fuel economy, this vehicle will offer only a spartan transportation mode at best. Compact cars of this volume also have a high damage and high fatality rate in moving accidents.

Student Worksheet

PRODUCT CARDS

CAR POOLING SYSTEM

A government agency in a large urban community is introducing a "Rideshare" program which uses a computer to match up prospective car pool participants by neighborhood and destination. An incentive of the program is preferential lane treatments which allows cars with four or more riders to use an express lane during rush hours. Your task is to develop a television commercial giving the telephone number of "Rideshare" and requesting people to call in and sign up.

ADVANTAGES

1. Participants will lessen their commuting time.
2. Participants will save both money and gasoline and reduce maintenance on personal vehicles.

DISADVANTAGES

1. Participating in a car pool lessens personal flexibility.

FACT

Car pools are useful, convenient and their implementation would greatly reduce traffic congestion into large urban areas.

NATURAL GAS HOME

Several builders backed by a regional natural gas association are offering an all natural gas energy package with discounts on the heating and cooling system, range, refrigerator and dryer if bought under this total package. At the time of this campaign there is a local oversupply of natural gas and your job is to design a television commercial to market the "all natural gas" home.

ADVANTAGES

1. Substantial savings can be made on the price of the appliances if they are bought as a package.
2. Natural gas is clean, convenient and currently is in good supply and favorably priced.

DISADVANTAGES

1. During the past few years, data shows seasonal shortages of natural gas and in some parts of the country, natural gas supplies have been exhausted.

FACT

National projections show that natural gas will decline in supply and domestic supplies will be exhausted in around thirty years. This is about the same length of time as current home mortgages.

Student Worksheet

PRODUCT CARDS

ELECTRIC AUTOMOBILE

This vehicle is being introduced during the middle of long gas lines in cities and suburban areas. Your task is to name the vehicle and develop an advertisement. Your vehicle is a compact, battery operated car with a range of forty miles and a battery charging cycle of twelve hours.

ADVANTAGES

1. Electric automobiles can furnish low cost per mile transportation in urban areas.
2. You do not need gasoline or other liquid fuels.

DISADVANTAGES

1. The short range of the vehicle limits its usefulness.
2. The long recharge period limits the time the vehicle can be used.
3. The vehicle is expensive, costing over $6,000.

FACT

The vehicle is effective for short, low speed trips. It uses high cost batteries which must be changed yearly. The mechanical components of the electrical system require weekly cleaning and maintenance and the vehicle must be driven a minimum of 100 miles per week over a three-year lifetime to be competitive with compact gasoline vehicles.

HOME INSULATION

This home insulation sale is being advertised during a time when heating bills are rising because of fuel costs. Your system, which you can give a name, can be blown into the walls and ceilings of older homes.

ADVANTAGES

1. Using the "blow in" system, the insulation can be put in the holes drilled through the walls of a home.
2. The insulation will reduce heating loads.

DISADVANTAGES

1. The material cannot be seen and "hot" and "cold" spots might develop.

FACT

1. Short of tearing off the siding or roof, this is probably the only way to add insulation to old homes.
2. While the insulation in the attic and ceiling is effective, there is no evidence to support drilling and filling the walls of previously constructed homes with insulation.

Student Worksheet

PRODUCT CARDS

SOLAR HEATING SYSTEM

A local company is placing on the market an active solar heating system which utilizes a roof mounted solar collector, piping and hot water storage and fan blown heater. The system may be built into new homes or retrofitted into older dwellings. The system is being introduced during a time of fuel oil shortages and increases in monthly electrical bills. Your job is to develop an advertisement for it.

ADVANTAGES

1. This system can produce 100% of the hot water needs of a household and 80% of the space heating needs during any given year.
2. The system uses sunlight as fuel.

DISADVANTAGES

1. The system performs poorly during cloudy weather.
2. The system requires monthly solar plate collector cleaning and maintenance.
3. The cost is expensive, about twice the cost of conventional systems. (Initially)

FACT

The solar heating system is a new technologicl advance and a lot of performance data are not available. The cost effectiveness of solar to conventional system is marginal and repairs require time. It is also necessary to install a conventional system for a backup to furnish heating during extended cloudy periods and during system repairs.

NEW MOTOR OIL

This new motor oil being marketed during a time of gasoline price increases contains a new ingredient which is not found in older petroleum based oils. It is your task to give it a name and advertise it.

ADVANTAGES

1. Increased engine lifetime and gasoline mileage.
2. Longer time interval between oil changes (8,000 miles as opposed to 6,000 for regular oils.

DISADVANTAGES

Cost is one and one-half times the cost of conventional oils.

FACT

The new oil is probably as good as the old oils and costs slightly more per mile to use.

Student Worksheet

PRODUCT CARDS

MICROWAVE COOKING SYSTEM

This new product uses microwaves to cook food very rapidly and a conventional electrical system to sear and brown meat. This combination system is moderately priced and requires no special carriers or holders to produce attractively cooked foods.

ADVANTAGES

1. The system has a very fast cooking time.
2. The system uses slightly less energy than an all electrical oven.

DISADVANTAGES

1. Cost is about one and one-half that of a conventional oven.

FACT

The cooking system produces an attractive and well-cooked food product. No research exists to show microwaves are correlated with any serious health problems. However, no research exists to show they are not.

BICYCLE

A major marketing campaign is being developed to boost the sales of a ten-speed bicycle designed for commuting short to medium distances. The bicycle is equipped with a ten-speed gear system, panniers capable of carrying packages up to briefcase size, safety reflectors, mirrors, positive braking system and a comfortable saddle. Your job is to design a television advertisement to promote the sales of this bicycle.

ADVANTAGES

1. The bicycle has improved safety and comfort features over conventional ten-speed bicycles.
2. The bicycle is powered by human mechanical power and is both fuel and money conserving.
3. The bicycle may be parked conveniently close to downtown business locations.

DISADVANTAGES

1. Bicycles are not as safe as cars or mass transit systems and are particularly hazardous in wet or icing weather conditions.

FACT

While bicycles are attractive for good weather commuting in terms of time, cost and convenience, they are not a good all weather transportation system.

Student Worksheet

TARGET AUDIENCE CARDS

ENGINEERING NUT

Members of this target audience spend all their time taking things apart and analyzing function. Buys most of their furniture and appliances in kit form and assembles it themselves. Impressed by data, charts, and graphs. Often sits for hours staring in awe at new slide rules and hand calculators.

SOCIAL BUTTERFLY

Members of this target audience spend all their time trying to find out when and where the next party is, regardless of whether they are invited or not. Trys to be totally value free so as not to offend anyone who might throw a party or be potentially an invitee to the Butterfly's own. Buys appliances that appeal to the need to prepare for large groups and is considering the purchase of a bus or truck to better manage group party arrivals.

NOSTALGIA BUFF

Members of this target audience yearn for the "good old days". Can often be heard using sayings from the last decade. Doesn't trust anything new unless it relates to something from yesteryear. Particularly loves old movies and old houses. Can't wait for parties and Halloween so they can wear 1940's clothes. Frequents second hand stores for wardrobe and home decorations. Buys only used books.

Student Worksheet

TARGET AUDIENCE CARDS

STATUS SEEKER

Members of this target audience want to be associated with the latest "In thing". Reads "Vogue" and "Bazaar" and clips out the pictures. Only wears shirts and pants that have the name on the outside. Thinks this is a great idea and wishes suits and shoes were made the same way. Has all the status credit cards and shows them often though seldom using them. Will buy anything new or different, particularly if sold in limited editions. Has never set foot in J.C. Penney.

ECO-FREAK

Members of this target audience would like to see the entire world designated as a wilderness area. Owns only denim shirts and hiking boots and is not comfortable unless sleeping under canvas. When presented with a product quickly asks "But what's the environmental impact?" Likes simplicity and sweat. Worships the Sun and recyclables.

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Student Worksheet

TARGET AUDIENCE CARDS

WILD AND CRAZY

Members of this target audience are characterized as wild and crazy. Everything is a joke and life is for fun. They spend money like its "going out of style" and resist having any serious thoughts. "Boogie today, worry later" is their motto. Travel in large, loud groups and can't stand to be alone for more than one hour.

SUPER INTELLIGENT

Members of this audience take great pride in their brainpower. Tend to like complex crossword puzzles and never miss reading "How to Increase Your Word Power" in magazines. Have trouble talking to anyone without a comparable I.Q. Thinks chess should be the new national pastime and totally distrusts simple straightforward statements. Must have all sides of issues and hopefully the books with primary information available before making a decision.

Student Worksheet

TARGET AUDIENCE CARDS

PLAIN OLD FOLKS

Members of this target population are hard to characterize because that's their most characteristic trait. Best described as being able to blend into any crowd, anytime. No distinctive clothes, cars or houses. Very home centered and won't go anywhere the whole family can't get into.

MONEY CONSCIOUS

Members of this target audience have one question, "What's the bottom line?" Greatly impressed with a bargain and spends hours going over the Thursday newspaper to pick out the specials at grocery stores. Has trouble enjoying dining out due to worrying about whether the waiter will figure the bill properly. Keeps records of every purchase and house is full of old sales slips.

SPORTS FANATIC

Members of this target audience read only "Sports Illustrated", "Field and Stream", and the local sports page. Hasn't missed a television football game in years and thinks Howard Cossell should run for President. Arranges entire life around seasonal sports, likes to share knowledge of esoteric sports facts with others of their kind. Has season tickets to everything.

Student Worksheet

ADVERTISEMENT EVALUATION SHEET I

As a member of the Consumer Evaluation Panel for Team Number ________ complete the following questionnaire:

1. Using Advertisement Evaluation Sheet II, circle the numbers which represent the:

Product	1	2	3	4	5	6	7	8	9	10
Target Audience	1	2	3	4	5	6	7	8	9	10

2. List the product's strength(s) ____

3. List the product's weaknesses ____

4. Did this advertisement influence you positively or negatively?

____

5. Were the strengths and weaknesses presented honestly? Yes No

6. Were the real facts presented? Yes No

Student Worksheet

ADVERTISEMENT EVALUATION SHEET II

Directions:

Use these descriptions to answer question one on Evaluation Sheet I.

PRODUCTS

1. New motor oil
2. Home insulation
3. Electric automobile
4. Mass transit ridership
5. Compact car
6. Solar heating system
7. Bicycle
8. Microwave cooking system
9. Natural gas home
10. Car pooling system

TARGET AUDIENCES

1. Wild and Crazy
2. Super Intelligent
3. Engineering Nut
4. Just Plain Folks
5. Money Conscious
6. Sports Fanatic
7. Nostalgia Buff
8. Status Seeker
9. Social Butterfly
10. Eco-Freak

LESSON #45

CATEGORY: Sources

ENERGY TYPE: All

TITLE: Analyzing the Energy News

GRADE LEVEL: 10-12

INFUSE WITH SUBJECT AREA:
Language Arts

TIME NEEDED: Two periods

MATERIALS:
Magazines and newspapers

OBJECTIVE:

The students will learn to critically evaluate by analyzing selected news articles or editorials.

TASK ANALYSIS:

The students should be able to read and comprehend printed news materials; to work in pairs; and to report to the class

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 45.2 - 45.3. Clip and collect biased articles and editorials on energy issues (or have students find and bring such items to class).

2. Steps in Lesson
   Objective: The students will learn to critically evaluate by analyzing selected news articles or editorials.

   a. Students should read and study Worksheet 45.2. (Optional) Students may use color coding or marking F for fact or O for opinion beside words and phrases in the articles. Discuss.
   b. Have each student (working independently) or a pair of students find an editorial or article in a newspaper or magazine which is biased toward a specific point of view. The teacher may need to clip and collect articles (with source and date noted on the article) before this lesson and hand them out to students.
   c. After reading their selected articles or editorials carefully, students should complete Worksheet 45.3.
   d. Students can share their insights into analyzing the news by a planned presentation that the teacher structures by assigning times and format.

3. Evaluation

   Students can be evaluated by using Worksheet 45.3 to analyze a different article or a television news special.

This lesson was written by Helen Holmes based on materials from National Science Teachers Association and from Dr. Jerry Long, Arkansas State University.

Student Worksheet

LOOKING AT TWO SIDES OF AN ISSUE: THREE MILE ISLAND

Directions: Read each account below carefully. But before you begin, review the following tips that lead to a better understanding of the arguments used to support a particular point of view:

-Separate facts from opinions.

-Guard against broad statements that may not be true in all situations.

-Avoid those statements that appeal to feelings only.

-Avoid emotion-loaded words.

A. THREE MILE ISLAND

An apparently routine pump failure in a nuclear reactor is compounded, by a combination of technical flaws and human errors, into a serious accident involving the release of considerable radioactivity into the atmosphere. For some days after the event, the inability of the reactor's safety system to cope with an unanticipated development (the generation of a large bubble of hydrogen gas in the reactor containment vessel) posed the imminent threat of the most serious of possible reactor calamities -- a core meltdown. Public confidence in nuclear reactor safety and its management is seriously eroded, not only by the facts of the accident but also by the falsification, evasions and generally irresponsible handling by company officials and some public servants of the information released to the public on the specific details, dangers and possible consequences of the accident, especially in the early, crucial stages.

B. THREE MILE ISLAND

A sequence of events resulting from a pump failure at a reactor causes the reactor to shut down. The emergency cooling system manages to cope with the technical failure and to prevent a dangerous loss of coolant, in spite of a number of technical problems encountered, most but not all anticipated. Although there results some relatively small release of radioactivity into the surroundings, almost all the radioactivity is contained within the reactor complex. The net result of what could, in the absence of careful advanced planning, have been a serious accident will be the loss of an important local source of electricity for a considerable period. However, in spite of over-blown fears expressed by badly informed critics, not a single individual has been physically injured.

Source: The Bulletin of The Atomic Scientists (May 1979, P. 6): author Bernard T. Feld

Student Worksheet

EVALUATING SOURCES -- ANALYZING THE NEWS

Select and carefully read an article or editorial about an energy issue from a current newspaper or magazine. Then answer the following questions that apply to your article or editorial. Continue answers on the back of the page if you need more space to write.

1. Did the article or editorial tend to favor one side or the other?

2. Give specific examples that show that the printed material favors one side of the issue, i.e. presents a biased point of view.

3. What was the writer's or reporter's intention in writing this article or editorial?

4. In your opinion, was the topic fairly treated? ______Yes______No. Explain answer.

5. Did the writer (or reporter) seem to have first-hand knowledge of the issue which he/she was reporting? Give examples.

6. Did the writer (or reporter) give sources of information? If so, list them.

7. Were the sources of information primary (quotes direct from a person) or secondary (told to someone else, reported to have said) sources?

8. Did the writer (or reporter) distinguish facts from opinions? What words indicate opinions are given? (example: it seems.....)

9. Locate and list any loaded words used in the article or editorial.

LESSON #46

CATEGORY: Conservation

ENERGY TYPE: Fossil Fuels

TITLE: Energy in Agriculture

GRADE LEVEL: 9-12

TIME NEEDED: One-Two Periods

INFUSE WITH SUBJECT AREA:

Science
Home Economics
Social Studies
Vocational Agriculture
Math

MATERIALS:

None

OBJECTIVES:

1. The students will gain an understanding of the energy required to produce various food products in the United States.

2. The students will gain an understanding of the energy required for field operations.

TASK ANALYSIS:

The students should have basic math skills; be able to read and interpret tables and be able to synthesize and analyze.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheets 46.3 - 46.8.

2. Steps in Lesson
   Objective #1: The students will gain an understanding of the energy required to produce various food products in the United States.

   a. Students will study and complete Student Worksheets 46.3 - 46.6.

   Objective #2: The students will gain an understanding of the energy required for field operations.

   a. Students will study and complete Student Worksheets 46.7 - 46.8.
      -Teacher will explain the mechanisms of various operations of farming, explaining how some operations are more energy-consuming than others.
      -Teacher will explain the differences between the categories of tillage, planting, and harvesting a crop.
      -Teacher will discuss factors which would affect gallons-per-acre totals in field operations.
      Discuss how some factors would increase gallons-per-acre totals, while others would decrease the totals.

This lesson was written by Alan Peek and Paul L. Butt.

3. Evaluation
Teacher may use Student Worksheet Questions to measure student growth in understanding of content. Answers to worksheet on 46.8a.

4. Follow-Up Activities

   1. Visit local supermarkets and obtain prices per given volume of the crop foods listed in Student Worksheet 46.5. Are the prices higher, the same as, or lower for the more energy-efficient foods? Discuss why or why not.

   2. Visit a minimum tillage farm and a conventionally-tilled farm and discuss the pros and cons with the landowners concerning why each has tilled as they have. Have specific questions ready to ask each landowner, and discuss the answers in class. Call County Soil Conservation Service Office to obtain the names of no-till farms in your area.

Student Worksheet

THE ENERGY REQUIRED TO PRODUCE FOOD PRODUCTS CONSUMED IN A YEAR BY ONE PERSON

Plant Product	Food Consumed (lbs./person/year)	Energy Required to Produce Food (gallons of oil/ person/year)	Ratio (lbs./gals)
Flour & Cereal	140.0	2.2	64
Sugar	122.0	1.4	____
Vegetable Oils	41.8	3.7	____
Fruits	131.5	1.9	____
Potatoes	104.9	0.6	____
Beans, Peas & Nuts	16.1	1.8	____
Green and Yellow Vegetables	215.1	2.3	____
Miscellaneous	14.8	0.2	____
	786.2	14.1	

Animal Product	Food Consumed (lbs./person/year)	Energy Required to Produce Food (gallons of oil/ person/year)	Ratio (lbs./gals)
Beef	116.0	19.1	____
Dairy	356.0	4.7	____
Pork	67.4	4.8	____
Animal Fats And Oils	14.6	3.5	____
Poultry	52.4	1.6	____
Eggs	39.0	1.3	____
Veal and Lamb	5.5	0.8	____
Fish	15.2	2.1	____
	666.1	37.9	

Source: United States Department of Energy

Student Worksheet

HOW MUCH ENERGY IN GALLONS OF OIL IS NEEDED TO GROW THE FOOD WE EAT?

Student Worksheet 46.3 shows the amount of fuel American farmers use to grow the food we put on our dining tables each year. First calculate the ratio of food consumed to energy required. Then fill in the blanks with the correct ratios for each food product. For example, for flour and cereal, the ratio is:

$$\frac{\text{Food Consumed}}{\text{Energy Required}} = \frac{\text{140 lbs./person/year}}{\text{2.2 gallons of oil/year}} = \frac{\text{64 lbs. of Food}}{\text{per gallon of oil}}$$

Next, answer each of the following:

1. Do plant products or animal products require the most gallons of oil to be produced?
2. The energy ratios on the chart are based on energy used in farming. The higher the ratio, the more efficient the farming process. What additional information would you need in order to say that a certain food product is energy-efficient?
3. Which two animal products would you eat if your only consideration was to choose energy-efficient products?
4. Which two plant products would you eat if your only consideration was to choose energy-efficient products?
5. What two animal products are the least energy-efficient?
6. What two plant products are the least energy-efficient?
7. What evidence in the table suggests why few nations in the world eat a large amount of beef?

Student Worksheet

WHICH PLANTS ARE ENERGY EFFICIENT?

When we say a farm crop is energy-efficient, we mean that the ratio of the food energy in the plant to the energy used in growing it is high. Some crops are more efficient than others; some are not as efficient. Look at the table below. Pick out your favorite food. Is it energy efficient? Remember that in reading the ratios, the higher the number, the more efficient the food is.

Look at the table, then answer each question.

Energy Efficiency Ratio for Common Crops

Crop	Ratio
Sorghum	5.3
Corn	4.4
Wheat	3.2
Soybeans	2.7
Oats	2.6
Potatoes	1.5
Rice	1.4
Apples	1.3
Grapes	1.1
Tomatoes	0.7
Green Beans	0.5
Peaches	0.6
Lemons	0.1

Source: United States Department of Energy

Student Worksheet

WHICH PLANTS ARE ENERGY EFFICIENT?
(Continued)

1. Which two crops get the best return in food energy from investments of energy used to grow and harvest them?

2. Which four are losing their energy-in/energy-out race?

3. Which four barely return the energy used in their production?

4. Playing a "What if . . . " game can give you plenty to think about. For example: What if . . . there were a great demand for more fruits and vegetables in the United States. What effect would this demand have on the following:

   a. The demand for fossil fuels?

   b. The price of oil and natural gas?

   c. Conflict between rich and poor nations?

Student Worksheet

ENERGY AND FIELD OPERATIONS

This table contains estimates for the average quantity of gasoline or diesel fuel required for most field operations used to produce corn and soybeans. The figures include only the fuel that is required for actual field work; no allowance is included for machine preparation or travel to and from the field.

Energy Requirements
Field Operations (Gallons Per Acre)

	Fuel Type	
Field Operation	Gasoline	Diesel
TILLAGE		
Shredding Cornstalks	0.90	0.60
Moldboard Plow	2.70	1.90
Chisel Plow	1.70	1.20
Offset Disk	1.35	0.95
Powered Rotary Tiller	2.30	1.60
Tandem Disk, Plowed Field	0.95	0.65
Tandem Disk, Tilled Field	0.80	0.55
Tandem Disk, Cornstalks	0.65	0.45
Field Cultivate, Plowed Field	1.15	0.80
Field Cultivate, Tilled Field	1.05	0.75
Spring-Tooth Harrow, Plowed Field	0.70	0.50
Spring-Tooth Harrow, Tilled Field	0.65	0.45
Peg-Tooth Harrow, Tilled Field	0.25	0.15
PLANTING (30-Inch Rows)		
Planter Only, Tilled Seedbed	0.45	0.30
Planter With Fertilizer and Pesticide Attachment, Tilled Bed	0.70	0.50
Till-Planter (Sweep)	0.60	0.40
No-Till Planter (Fluted Coulter)	0.50	0.35
Harrow-Plant Combination	1.15	0.80
Rotary Strip-Till Plant	1.50	1.05
Grain Drill	0.50	0.35
HARVESTING		
Combine, Soybeans	1.70	1.10
Combine, Corn	2.35	1.60
Corn Picker	1.75	1.15

Source: Iowa State University

Student Worksheet

FIELD OPERATIONS:
ALTERNATIVES AND CONSERVATION MEASURES

Many farmers in some parts of the country use some form of minimum tillage. It is a method that has application in Arkansas. Minimum tillage is used in many forms including single pass operations, such as the till planter, and other forms such as disking and planting, disking and listing, or shredding, disking, and planting. The plow, a high consumer of energy, is eliminated with minimum tillage. Although most methods of raising crops in Arkansas include some form of minimum tillage, such as disking and planting or disking and listing, till plant and slot plant could make field time even more effective. Slot planting or till planting methods require the least fuel of all the common cropping methods and use only three operations; planting, spraying and harvesting.

For the best possible use of fuel, farmers should eliminate any unnecessary field operations, eliminate unnecessary travel, eliminate engine idle time and choose operations that have lower energy requirements.

Questions:

1. If in getting a field ready, planting and harvesting a crop, a farmer, (1) moldboard plows, (2) tandem disks the plowed field, (3) harrows (spring tooth), (4) plants with fertilizer and pesticide attachment, (5) cultivates (plowed field), and then (6) combines the soybeans, how much fuel (gas and/or diesel) will be used per acre?

2. If gas sells for 125.5¢ per gallon and diesel 99¢ per gallon, what would be the dollar investment of fuels in question one?

3. Which major field operation (tillage, planting, or harvesting) is the most energy-consuming? Which is the least energy-consuming? What is the gallons per acre total of each of the three field operations?

4. What is minimum tillage farming? What effect does this have on energy consumption in field operations?

Student Worksheet

ANSWERS

Worksheet 46.3

Plant Product:	86, 11.3, 68.9, 175, 9, 93.5 74
Animal Product:	6.1, 75.0, 14.0, 4.2, 32.8, 30.0, 6.9, 7.2

Worksheet 46.4

1. Animal products
2. The total amount of useful food in the product; the amount of energy needed to process the food.
3. Dairy and poultry
4. Potatoes and green and yellow vegetables
5. Beef and animal fats and oils
6. Beans, peas, nuts, vegetable oils
7. It takes too much energy to produce beef and costs too much

Worksheet 46.6

1. Sorghum and corn
2. Tomatoes, green beans, peaches and lemons
3. Potatoes, rice, apples and grapes
4. a. The demand would increase
    b. The price would rise
    c. Answer will vary. Conflict could erupt if rich nations were to hoard certain foods or put unfair restraints on food sales.

Student Worksheet

ANSWERS

Worksheet 46.8

	Energy Requirements In Gal./Acre	
	Gasoline	Diesel
1. Moldboard Plows	2.70	1.90
Tandem Disk, Plowed Field	.95	.65
Harrows (Spring-Tooth)	.70	.50
Plants with Fertilizer and Pesticide Attachment	.70	.50
Cultivates (Plowed Field)	1.15	.80
Combine Soybeans	1.70	1.10
	7.90	5.45

2. 7.90 gallons of gas per acre x 125.5¢ per gallon = $9.9145 gas per acre; 5.45 gallons diesel per acre x 99¢ per gallon = $5,3955 diesel per acre.

3. Tillage is the most energy-consuming; gas = 15.15 gallons per acre; diesel = 10.55. With diesel, planting is the least consuming with 3.75 gallons per acre; with gas, harvesting is the least consuming with 5.10 gallons per acre.

Totals For Each (Gallons Per Acre)

	Gas	Diesel
Tillage	15.15	10.55
Planting	5.40	3.75
Harvesting	5.10	8.95

4. Minimum tillage farming is a single pass operation involving disking, planting, listing, shredding, and planting all at one time. The plow is eliminated. The effect it has on energy consuming in field operations is that it is a conservative measure on fuel consuming, and consequently is profit-motivated.

LESSON #47

CATEGORY: Impacts

ENERGY TYPE: Lignite

TITLE: Boom Town:
Do You Want It?

GRADE LEVEL: 10-12

INFUSE WITH SUBJECT AREA:
Social Studies

TIME NEEDED: Four to Six
Periods

MATERIALS:
None

OBJECTIVES:

1. The students will become aquainted with the Arkansas lignite resources and their impending development.
2. The students will gain understanding of the interdependence of various economic, environmental and human factors in a community.
3. The students will analyze advantages, disadvantages and options in determining whether or not a community would desire to become a "boom town."
4. The students will learn the multiplier effect on surrounding communities due to economic change in one community.

TASK ANALYSIS:

The students should understand energy and economic vocabulary; be able to read and interpret maps and charts; be able to use the skills of synthesis and analysis of printed material for decision-making purposes; be able to understand the purpose and mechanics of role-playing

PROCEDURE:

1. Preparation
   Duplicate Student Background Information and Worksheets 47.5 - 47.16.
   Read Teacher Background Information (47.4).

2. Steps in Lesson
   Objective #1: The students will become acquainted with the Arkansas lignite resources and their impending development.

   a. Have students read Student Background Information 47.5 - 47.13 in class.
      If time permits, class discussion can follow.

   Objective #2: The students will gain understanding of the interdependence of various economic, environmental and human factors in a community.

   a. Discuss how the activities of one group affect the activities of one or more of the other groups. For example, as the mining company clears land for mining purposes, habitat used for hunting purposes is depleted. Another example would be as the community grows

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This lesson was written by Alan Peek.

community services must adapt to meet the demands of the residents. Services such as utilities, supermarkets, clothing outlets and law enforcement are essential community functions for residents.
Distribute Student Worksheet 47.14. Have each student choose a group in which he/she will participate.
Explain how the role-playing will be conducted in class. Stress that each group should prepare for its presentation to the City Council.

Objective #3: The students will analyze advantages, disadvantages and options in determining whether or not a community would desire to become a "boom town."

a. Allow interaction of the various special interest groups to bring about the advantages, disadvantages and options of the proposed power plant installation and operation. Emphasize the importance of tradeoffs involved in such a discussion.
b. Have City Council members bring out the pros and cons from each group's presentation.
c. Have City Manager act as the moderator during the role playing.

Objective #4: The students will learn the multiplier effect on surrounding communities due to economic change in one community.

a. Include the surrounding communities' interest in all applicable discussion. For example, would a neighboring community profit from the power plant in your community? If so, in what ways? The answer would be, of course, yes, and the ways it would profit would be very similar to your own community's ways of profiting from the power plant.
b. Stress the concept that energy issues, like economic issues, affect everyone involved. Not only employees, but their families, merchants, utilities, local services, institutions and many other community facets will feel that impact of such an industry. In essence, capital can and often does multiply itself both inside and outside a community.

3. Evaluation

Use the Student Worksheets 47.15 - 47.16 as evaluation of student interest and growth in understanding.

4. Follow-Up Activities

a. Instructor may modify lesson to fit his/her locality. If a mine-mouth power plant is not pertinent to your community, use another related topic, such as a biomass converter system, nuclear power plant, massive hydro-electric generation system, etc.

b. Contact local Chambers of Commerce of several boom towns, both in and out-of-state. Ask about their problems and solutions in becoming a boom-town.

TEACHER BACKGROUND INFORMATION

Sources:

Arkansas Energy Office. Arkansas Energy Future: Lignite. Little Rock. 1979.

Paul L. Butt. Arkansas and Energy: A Look at The Alternatives. Arkansas Ecology Center: Little Rock. 1979.

Arkansas, as many other states, is rapidly approaching an energy dilemma: should Arkansans make use of our energy resources, and, if so, to what extent? Arkansas has a variety of energy resources, some of which have vast potential as an immediate energy supply. Lignite is such an energy resource.

This lesson deals with decision-making and will provide insight to the ability to make energy choices and/or alternatives. Lignite, with its huge Arkansas reserves, is definitely slated for usage in the 1980's. How will Arkansans adapt to the environmental, social and economic changes that will come as a result of lignite energy usage? This lesson should supply both teachers and students with enough facts and background information to allow for intelligent answers.

STUDENT BACKGROUND INFORMATION

Source:

Paul L. Butt. Arkansas and Energy: A Look at The Alternatives. Arkansas Ecology Center: Little Rock. 1979.

ARKANSAS LIGNITE: DEVELOPMENT APPEARS CERTAIN

Until recently, little attention was given to the lignite (low-grade coal) deposits in Arkansas. Lignite, a brownish black coal that still bears plant fragments, was mined in Arkansas intermittently from the 1860's to 1945 and used for domestic fuel, a source of dye, and distilled oil. With the declining supply of natural gas and the need to reduce dependence on foreign sources of oil, the potential that lignite offers Arkansas as a major domestic fuel source has been recognized.

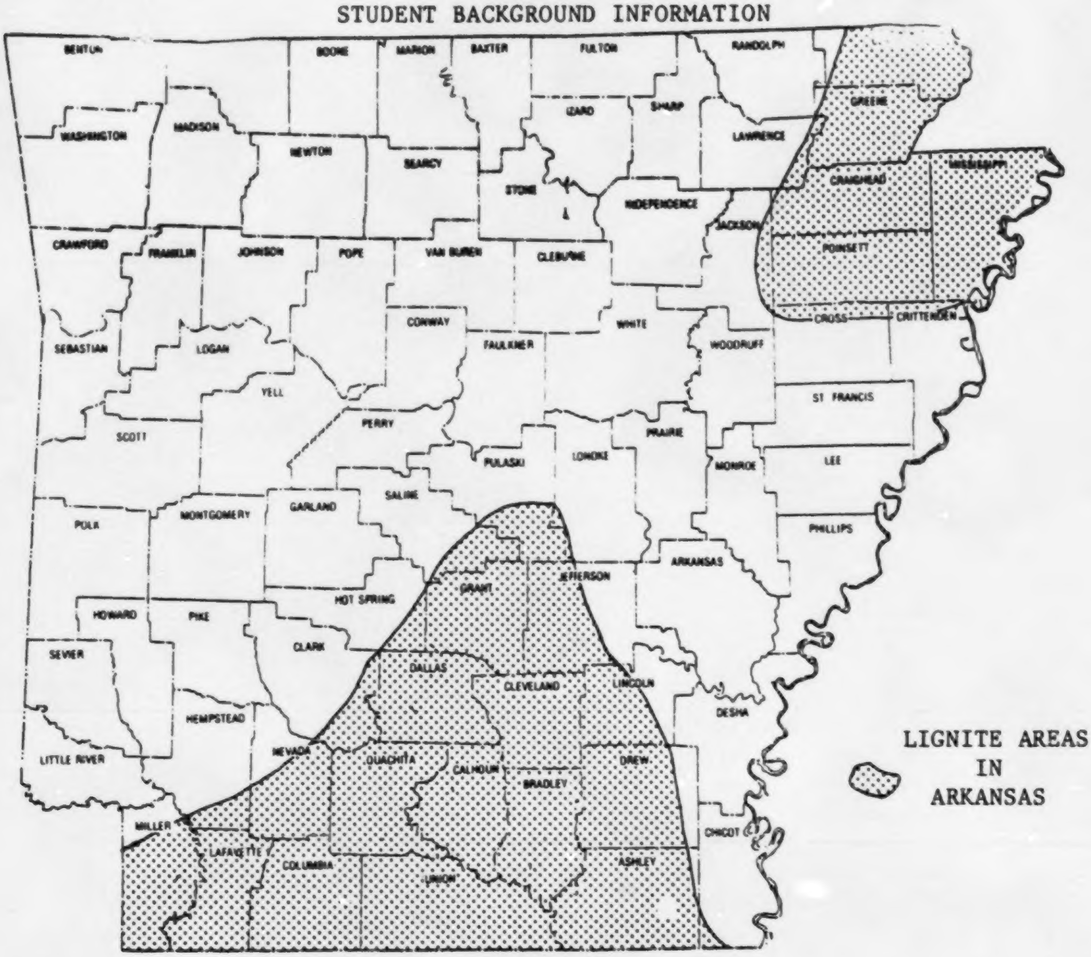
Arkansas lignite has a high moisture content, a low heat value, and is low in sulfur. It generally appears borderline as a "compliance" coal with sulfur content averaging less than one percent. The lignite can be utilized as a direct fuel to generate heat and electricity, and can probably be used for gasification and liquifaction. "Lignite" has now become a common word in the vocabularies of many Arkansans. The large lignite resources of Arkansas offer a potentially abundant and indigenous source of energy. Lignite is certain to be a significant component in any planning for the state's future energy needs.

The present increasing interest in lignite use is attributable to several factors: oil and natural gas resources are declining and prices are rising; technology already exists for specific methods of lignite production and use; capital and operating costs for many existing lignite technologies are competitive in today's marketplace; and current government policy is directed toward expanded coal and lignite use.

Government and commercial investigations indicate Arkansas has abundant lignite deposits in South Arkansas and in the Crowley's Ridge area of northeastern Arkansas (Figure 1). Lignite resources in the state are estimated to be up to 13.5 billion tons. Three companies began extensive lignite leasing and exploration in 1974-75. The recoverable reserves reported by General Crude Oil Company (a subsidiary of International Paper Company), Carter Oil Company (an Exxon subsidiary), and Phillips Coal Company (a subsidiary of Phillips Petroleum) are about three billion tons.

Since Arkansas lignite has an average heating value of 6000 BTU per pound -- about half the heating value of Wyoming coal -- the estimated reserves represent an energy equivalent of almost eight billion barrels of oil. Although lignite must be mixed with higher-grade coal for use in conventional coal-fueled power plants, lignite can be the sole fuel in plants with boilers specifically designed for its fuel characteristics. Arkansas lignite is generally considered a viable fuel alternative to Wyoming coal for needed electrical generation in the post-1985 timeframe.

STUDENT BACKGROUND INFORMATION


BENTON
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BAXTER
FULTON
RANDOLPH
GREENE
WASHINGTON
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SEARCY
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SHARP
LAWRENCE
CRAIGHEAD
MISSISSIPPI
STONE
INDEPENDENCE
JACKSON
POINSETT
CRAWFORD
FRANKLIN
JOHNSON
POPE
VAN BUREN
CLEBURNE
CROSS
CRITTENDEN
SEBASTIAN
LOGAN
CONWAY
FAULKNER
WHITE
WOODRUFF
YELL
ST FRANCIS
SCOTT
PERRY
PRAIRIE
PULASKI
LONOKE
MONROE
LEE
SALINE
GARLAND
POLK
MONTGOMERY
PHILLIPS
ARKANSAS
JEFFERSON
GRANT
HOT SPRING
HOWARD
PIKE
CLARK
SEVIER
DALLAS
CLEVELAND
LINCOLN
DESHA
HEMPSTEAD
LITTLE RIVER
NEVADA
OUACHITA
CALHOUN
DREW
BRADLEY
MILLER
CHICOT
LAFAYETTE
COLUMBIA
UNION
ASHLEY
LIGNITE AREAS
IN
ARKANSAS

There are 75 counties in Arkansas; 31 of these 75 counties have lignite deposits in them. Of the 31, 13 counties have lignite throughout the entire county and 18 have lignite in only part of the county. The abundance of lignite makes it a desirable source of energy for Arkansas.

STUDENT BACKGROUND INFORMATION

Mine-Mouth Plants and Long-Term Contracts

It is estimated that Arkansas lignite, even if it does not comply with air quality standards, will be cost-competitive with Wyoming coal. Although lignite has a heating value only half that of Wyoming coal, the lignite does not incur the transportation costs of hauling Wyoming coal to Arkansas. Due to lignite's higher volume-to-BTU ratio and a tendency toward spontaneous combustion when shipped, the use of lignite in Arkansas will be largely restricted to localities of occurrence.

Arkansas lignite will primarily be used by "mine mouth" power plants. A mine-mouth plant represents an alternative to delivering lignite to the market: The market is brought to the lignite. The power plant is built as close as possible to the lignite mine. Thus, transport costs on the lignite are minimal.

Many physical and chemical characteristics of coal affect its suitability for use in electrical generation. In the mid-western and western United States, unlike the east, there is virtually no "spot" market; most utility coal is sold under long-term contract. From a utility company's standpoint, it is desirable to contract for high-quality, low-sulfur coal that is available in sufficient quantity to supply a power plant for 30 years. It is not always possible to obtain high-quality coal or low-sulfur coal, but the availability of sufficient quantities of minable reserves is essential in long-term contracting. In part this is because the power plant boilers must be designed to burn a specific type of coal, as defined by heating value, ash content, moisture content, sulfur content, and other factors. Therefore, once a power plant is in operation, the utility company must be assured of a steady supply of coal with the desired characteristics for the life of the plant, which usually is expected to be about 30 years.

Preferably, from the utility company's viewpoint, one supplier will have leased or purchased the required reserves in a more or less continuous block. The ease of difficulty with which large blocks of Arkansas lignite reserves are accumulated depends on the extent, continuity, thickness, and other characteristics of the lignite deposit. Only in the last several years has such information been available.

Electrical generation is considered the leading use for lignite. But Arkansas lignite also represents a potential for gasification and liquifaction. In general, processes which are suitable for bituminous coal can also be used with lignite. The Carter Oil Company sent a 110-ton lignite sample from near Sparkman in Dallas County to Germany for pyrolysis tests. Pyrolysis is the high-temperature decomposition of a material in the absence of oxygen. Carter Oil termed the results of the burning, which produced oil and a residue called "char" that can be used as a boiler fuel, "very encouraging" on a preliminary basis. Some planners envision an additional future for lignite in industrial parks, perhaps built around mine-mouth electric power plants. Additional lignite could be used at these sites in pyrolysis to produce materials for industrial processes.

STUDENT BACKGROUND INFORMATION

"Ignite the Lignite"*

In 1978, the Arkansas Public Service Commission (PSC) granted three Arkansas electric utilities permission to construct a power plant fueled by low-sulfur Wyoming coal in Independence County. With regard to lignite, the PSC said:

> We conclude that it would be unwise to delay the construction of generating facilities that will be needed in the 1983 to 1985 period when it is clear that lignite cannot be developed and in use by those dates. However, the cost comparisons of Western coal and lignite presented in this proceeding, the secondary economic benefits that will accrue to the state from the development of lignite, the absence of any risk of escalation in the transportation costs of lignite, and the effect of the Clean Air Act Amendments of 1977 make Arkansas lignite the pre-eminent choice as a fuel for future generating plants. . . (PSC order of August 31, 1978).

In 1979, Arkansas Power and Light Company (AP&L) and Arkansas Electric Cooperative Corporation (AECC) announced plans for the construction of a lignite mine and two-unit, lignite-fueled power plant in Calhoun County that will cost an estimated 1.8 billion dollars (in 1988 dollars). The mine and power plant will comprise what will be known as the Arkansas Lignite Energy Center. The Center will consist of two 750-megawatt generating units and will be constructed adjacent to the mine. The surface mine will be developed by a recently-formed firm called the G-S Lignite Partnership on parts of 47,000 acres that surround the town of Hampton. The partnership is composed of GCO Minerals Company, a subsidiary of International Paper Company, which owns the timber-covered land, and Shell Oil Company, which will design, construct, and operate the mine.

According to plans, about 30,000 acres of land will be mined, beginning in the late 1980's, with 1000 acres being stripped at any one time. The mine is expected to produce more than eight million tons of lignite per year, which will make it one of the largest surface mines in the United States. Plans are for construction of the first generating unit to begin in the late 1980's. The second generating unit is scheduled for construction in the early 1990's. It appears that the lignite reserves around Hampton are sufficient to fuel the Center for 30 years, the expected life of the plant. Unlike the coal-fueled power plants in operation or under construction in the state, the Arkansas Lignite Energy Center will be equipped with scrubbers to clean sulfur oxides from emissions.

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*Arkansas lignite supporters' T-shirt message.

STUDENT BACKGROUND INFORMATION

A Challenge: Avoiding the "Boom Town"

When Arkansas lignite reserves are developed, substantial benefits could accrue to the area's economy. Rather than dollars flowing out-of-state for the purchase of coal, the money will stay in Arkansas and, through the multiplier effect, stimulate general economic development in south Arkansas. Benefits could include an expanded and diversified economic base, a larger tax base, inmigration of skilled labor, increased personal income, and an increased energy supply. It is estimated that the net economic benefits to the Arkansas economy of the Arkansas Lignite Energy Center will be over 150 million dollars.

Recent experience in Texas and North Dakota, where lignite is already used for electrical generation, has indicated that the rapid growth resulting from energy projects can also create many socio-economic and environmental problems. An influx of people into the lignite development areas could strain existing social and economic structures. A "boom town" situation could be created. Lignite-related development will typically occur in small communities and rural areas with limited capability for planning and managing rapid growth. This could result in a serious taxing of the local infrastructure together with housing shortages and creation of low-quality housing; serious inflation in land prices; congestion and overcrowding; inadequate community facilities and services; social problems such as alcoholism, depression, delinquency, and clash of values; and change in pace, lifestyle, and quality of life. The local communities may receive few of the tax benefits, yet they will have the burden of providing facilities and services for the new residents.

Avoiding these socio-economic problems will offer a hefty challenge to the local and state governments charged with protecting the health, safety, and welfare of their populations. The problems result from the traditional, business-as-usual boom in which unmanaged growth is the cumulative result of many different corporate, governmental, and individual decisions, mostly made in isolation from each other. The results of such unmanaged growth will likely be the leading source of upsets and conflcits that can be anticipated in the process of Arkansas' lignite development.

The impacts of lignite development will vary from community to community and so will the possible solutions. An Ozarks Regional Commission study identified three "major ingredients necessary to minimize the adverse impacts:" planning, financing, and cooperation. Effective planning is essential to anticipate the effects of development and to understand the local area needs and desires, and the possible tradeoffs. Financing is important because, especially in the early stages of a project, the public costs can significantly exceed benefits.

STUDENT BACKGROUND INFORMATION

The needs for local financing can be met in a number of ways, including internal financing through increased taxes or issuance of bonds, financing from the project developer, and financing from a higher level of government. Perhaps the most important of the three "ingredients" is cooperation. In order for lignite development to occur smoothly and successfully, it must be recognized that all parties in the proposed development have a legitimate interest in the project. Although these interests may conflict, such as the economic and environmental interests, the success of the development will depend in large measure on the mutual respect and cooperation of the various parties.

Lignite Mining: Troubled Waters

Arkansas lignite genrally lies at shallow depths under overburden (overlying materials) that contain no rock. As a result, the lignite cannot be mined underground; surface mining is the only feasible extracting technique presently available. The depth of the overburden varies significantly. In the deposits already leased, the overburden is generally 20 to 250 feet thick.

The most critical environmental issues related to lignite mining are the effects on water resources. Lignite mining could have significant adverse effects on both surface and groundwater. Due to the significant quantities of water in the overburden, it will be necessary to dewater the mine sites before actual mining can begin. Water from the mines could be discharged to local streams, thus affecting the water quality in these streams. Erosion of exposed mine spoils could lead to pollution of nearby streams with silt. Increased silt in a stream adversely affects to aquatic ecosystems and affects the frequency and severity of flooding. Mining could produce chemical changes in the groundwater resulting from the exposure of the overburden materials. Mining could also cause the lowering of the groundwater level in surrounding areas.

The large-scale surface mining of lignite will have adverse effects on an area's ecosystems, disrupting and destroying wildlife habitats. Air pollution will occur with the emission of "fugitive" dust from the mining operations. Most of the land in the Arkansas lignite areas is used for timber production. The land will be severely disrupted by the mining operation and will need to be reclaimed. If the land is to be restored for forestry, the newly-planted trees will not provide adequate erosion control and the problems of erosion and silting of streams could continue after mining and reclamation. Most of the land can be reclaimed, but without strictly interpreted and enforced regulations, the mining companies generally do not adequately restore the land.

The intent of the Arkansas Surface Coal Mining and Reclamation Act of 1979 was to "assure that surface coal mining operations are so conducted as to protect the environment." Lignite falls under the definition of coal in this Act. Some major features of this law include: 1) In order to obtain a mining permit, mine operators are required to prove beforehand that they can relcaim the land, and must post a bond, the amount of which will be sufficient to assure reclamation; and 2) the land must be restored so that it can be used for the same purposes as it was utilized before mining. Such restoration includes filling in holes, contouring the land to its original shape, preserving all soil, removing all wastes, and replanting the land with grasses and trees. If interpreted and enforced strictly, and adequately funded, this law could go a long way to protect valuable ecosystems from the effects of the surface mining of Arkansas' coal and lignite.

LOCAL HEARING!
LOCAL NEWS
CITY COUNCIL REACHES DECISION!!

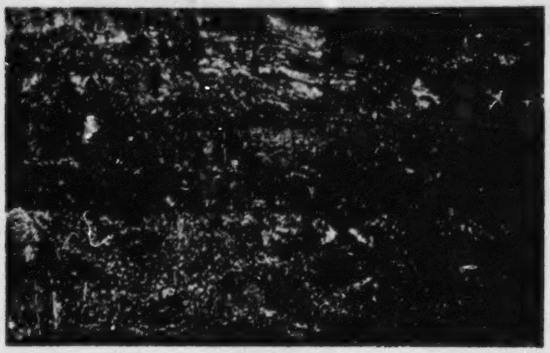


Figure 2

Lignite seams found in Hot Spring County near Malvern.

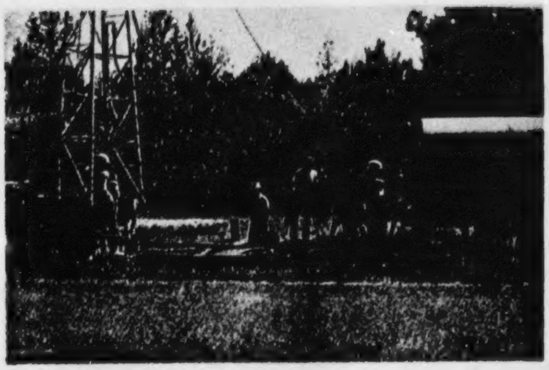


Figure 3

Drill operated by Arkansas Geological Commission, Ouachita County, in search for valuable lignite seams.

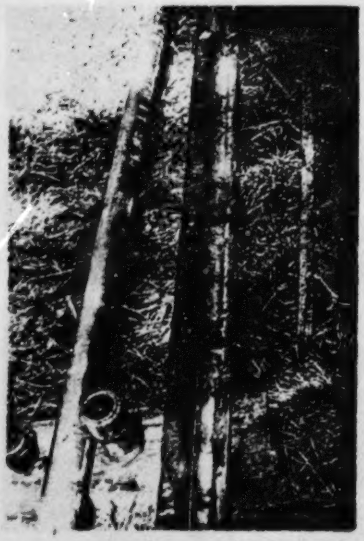


Figure 4

Lignite core ready for analysis.

Source: Arkansas Energy Office. Arkansas Energy Future: Lignite. Little Rock. 1979.

Figure 5

Cored section of lignite showing carbon-rich clay layered with lignite.

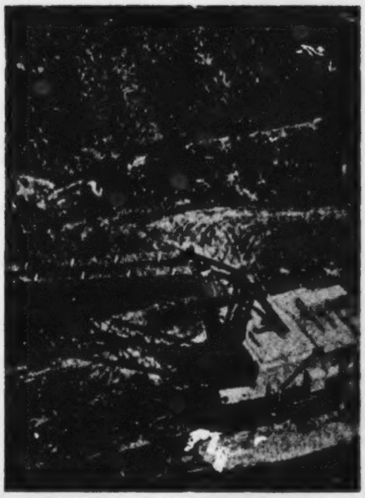


Figure 6

Extracction of lignite in Texas mine by a huge dragline.

Figure 7

Larget bucket wheels such as this one could be used in extracting Arkansas lignite.

Source: Arkansas Energy Office. Arkansas Energy Future: Lignite. Little Rock. 1979.

Student Worksheet

Assume you live in one of 31 Arkansas counties where major lignite deposits are found. Mining exploration has shown that just inside your community's city limits, there is a sizeable amount of lignite within 250 feet of the surface. The mining company in charge of the exploration speculates that there are enough lignite deposits to fuel a mine-mouth power plant for a minimum of 30 years.

The purpose of this lesson is for you to decide, through role-playing, whether or not you want this facility in the local community. You will become a member either of the local City Council or one of the six special interest groups. Each special interest group will prepare a 20-minute presentation to the City Council, stating its concerns and whether or not the community should approve the installation and operation of a mine-mouth power plant. The City Council will consist of four members and the City Manager, who presides over all meetings. At the end of all presentations, the City Council will hold an open session with the special interest groups and the public, using question-and-answer to the special interest groups. After all discussion, the City Council members will vote to decide if it will permit the mine-mouth power plant to be located in the community. The city Manager may vote if a tie vote exists among City Council members.

The six special interest groups and their concerns are as follows:

1. CONCERNED CITIZENS: pollution, aesthetics, habitat loss, recreation
2. COMMUNITY SERVICES: residential and commercial planning, law enforcement, schools, medical care, utilities, transportation
3. LOCAL BUSINESSES: supply and demand, future development
4. MINING REPRESENTATIVES: approval of proposed power plant project; profit accrued will help the communtiy
5. RURAL SECTOR: farming, land usage, water usage
6. STATE AND FEDERAL INTERESTS: revenue, transportation, land usage

Student Worksheet

EVALUATION

Directions: Match the community concern with the special interest group; there may be more than one answer per blank.

________________________________ 1. Local Businesses

________________________________ 2. Rural Sector

________________________________ 3. Mining Rrepresentatives

________________________________ 4. Concerned Citizens

________________________________ 5. State and Federal Interests

________________________________ 6. Community Services

a. residential planning
b. supply and demand
c. schools
d. water usage
e. aesthetics
f. transportation
g. law enforcement
h. farming
i. recreation
j. medical care
k. habitat loss
l. land usage
m. future development
n. commercial planning
o. revenue
p. utilities
q. pollution
r. convince community to approve proposed power plant project

Directions: Fill in the blank with the correct answer.

7. ____________________ refers to an economic theory stating that as one segment of the economy flourishes, other segments will also flourish.

8. ____________________ are by-products of fossil fuel combustion; are heavy, colorless, suffocating gases.

9. ____________________ refers to a contract by which one party gives to another party the use and possession of land, buildings, etc. for a specified time and for fixed payments.

10. ____________________ is an economic theory stating that a given good or service may be exchanged for another desired good or service.

11. ____________________ refers to restoring land to its original status after a land disturbance.

12. ____________________ is any material potentially usable as an energy source.

Student Worksheet

EVALUATION
(Continued)

Directions: Answer the following questions.

13. What is the physical and chemical property of lignite that makes it a "compliance" coal?

14. What is the major reason given for locating a power plant at the site of the energy source (a mine-mouth power plant)?

15. Should citizens be concerned if a power plant does not install scrubbers? Why or why not?

16. In what ways could water resources be affected by lignite mining?

17. What are the two major features of the Arkansas Surface Coal Mining and Reclamation Act of 1979?

Directions: Write the word TRUE or the word FALSE in the blank at the left of the statement.

18. _________ Cooperation is the single most important ingredient in the development of lignite as an energy source in Arkansas.

19. _________ A major problem with "boom-towns" is an increase in the tax structure.

20. _________ The Ozark Mountains of northwest Arkansas have one of the largest lignite deposits in Arkansas.

Student Worksheet

EVALUATION

ANSWER SHEET

1. b, m
2. d, h, l
3. r
4. e, i, k, q
5. f, l, o
6. a, c, f, g, j, n, p
7. Multiplier effect
8. Sulfur oxides
9. Leasing
10. Tradeoff
11. Reclamation
12. Energy resource
13. Lignite is low in sulfur content.
14. Lowered transportation costs.
15. Scrubbers are used to remove sulfur oxides; these gases are heavy polluters and cause serious consequences for persons with respiratory problems.
16. a) Water from inside the mine could be discharged to local streams; b) erosion of exposed mine spills could lead to pollution of nearby streams with silt; c) mining could produce chemical changes in the groundwater resulting from the exposure of the overburden materials; d) mining could lower the groundwater level in surrounding areas.
17. Essentially, 1) mine operators are required to show beforehand they can reclaim the land and must post a bond to cover any or all reclamation costs, and 2) the land must be restored to its former status of usage.
18. TRUE
19. TRUE
20. FALSE

LESSON #48

CATEGORY: Sources

ENERGY TYPE: Nuclear Fusion

TITLE: Fuel in the Sun

GRADE LEVEL: 10-12

INFUSE WITH SUBJECT AREA:
Science
Social Studies

TIME NEEDED: One Period

MATERIALS:
None

OBJECTIVES:

1. The students will gain a knowledge of fusion reactions and the harnessing of fusion for energy.
2. The students will gain a knowledge of the present development and future plans/hopes for fusion power.

TASK ANALYSIS:

The students should be able to read and comprehend semi-technical material.

PROCEDURE:

1. Preparation
   Duplicate Student Information 48.3 - 48.7.
   Read Student Information 48.3 - 48.7.

2. Steps in Lesson
   Objective #1: The students will gain a knowledge of fusion reactions and the harnessing of fusion for energy.

   Objective #2: The students will gain a knowledge of the present development and future plans/hopes for fusion power.

   a. Distribute Student Information 48.3 - 48.7. Give students sufficient time to read Student Information. Teacher will request that students use a dictionary, if necessary, to define any unfamiliar terms.
   b. In remaining time, hold a class discussion on nuclear fusion. Topics might include:
      -Economics of fusion vis-a-vis other energy alternatives
      -Environmental impacts of fusion vis-a-vis other energy alternatives.
      -Fusion: pros and cons

This lesson was written by Alan Peek and Paul L. Butt

3. Evaluation

Statements, questions and answers in discussions can be used as an assessment of understanding gained by students.

4. Follow-Up Activities

Given the opportunity to collect the necessary background information, students can describe, in writing, how the current attitudes about fusion reactors might influence the development of nuclear power sources. Students could extend the discussion into the topics of working conditions, future jobs markets and environmental changes.

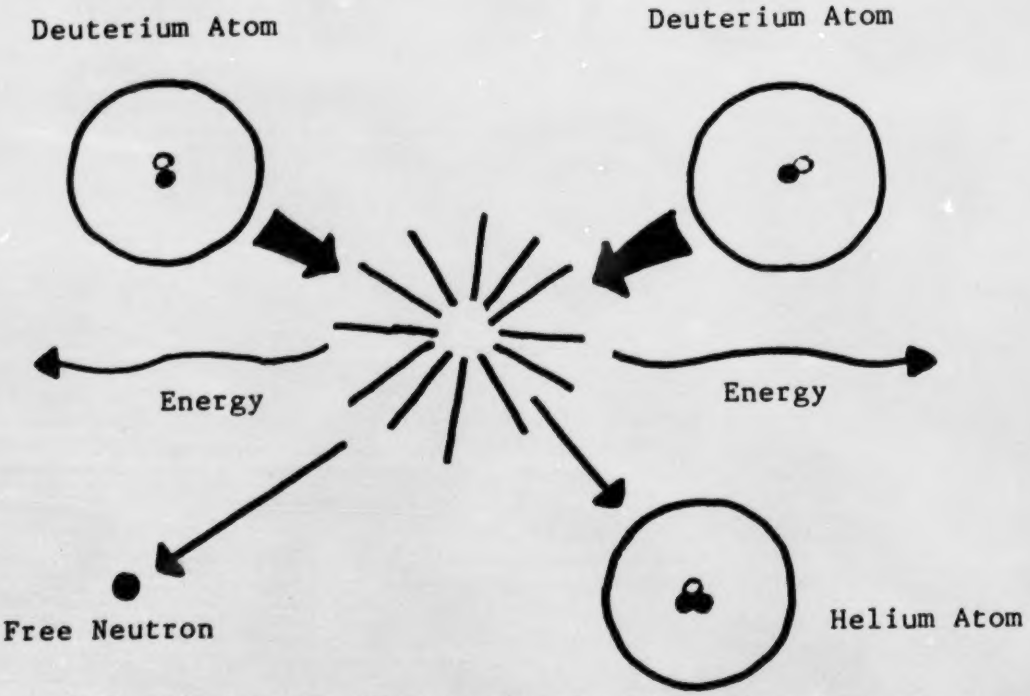
STUDENT BACKGROUND INFORMATION

Source:

Paul L. Butt. Arkansas and Energy: A Look at The Alternatives. Arkansas Ecology Center: Little Rock. 1979.

Fusion: Another Kind of Nuclear Energy

The potential energy locked in the nucleus of an atom can be released by either of two processes: nuclear fission or nuclear fusion. Basically, fission is the splitting of heavy atoms to release energy; while fusion is the welding of light atoms to release energy. In nuclear fission, a neutron is used to split the nucleus of a heavy atom such as uranium-235 into two lighter fragments with the release of additional neutrons and energy. In nuclear fusion -- the process by which the sun and other stars generate their energy -- two nuclei of light, non-radioactive atoms (such as hydrogen) are forced together to form a heavier nucleus (such as helium), releasing energy.* Fusion produces ten times as much energy per equivalent weight of fuel as fission.



Nuclear Fusion, or a Thermonuclear Reaction, takes place only at extremely high temperatures. In one fusion reaction, two atoms of deuterium, or heavy hydrogen, fuse to form an atom of a light isotope of helium and release a neutron. This reaction also releases huge amounts of energy in the form of heat.

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*Every second, 650 million tons of hydrogen are fusing into 645.4 million tons of helium at the sun's center. This process produces energy. Each missing 4.6 million tons per second represents the energy that pours out of the sun in all directions. A very small fraction is intercepted by the earth, and on that energy, all life on earth is supported.

STUDENT BACKGROUND INFORMATION

In laboratories in the United States, the Soviet Union, Japan, and western Europe, scientists are attempting to harness nuclear fusion as a source of energy. At present, the two most attractive fusion reactions are the D-D reaction, in which two deuterium (or hydrogen-2) nuclei fuse to form a helium-3 nucleus, and the D-T reaction, in which a deuterium nucleus and a tritium (hydrogen-3) nucleus fuse to form helium-4. Since atomic nuclei have positive electric charges, they repel one another and stubbornly resist fusing. Forcing the nuclei together requires an ignition temperature of about one billion °C, Due to its much lower ignition temperature of about 100 million °C, the D-T reaction is the only one being seriously developed at this time.

Fusion reactors will have important advantages over fission reactors, including:

1. Fusion is much less hazardous than nuclear fission. Reactor meltdown with a serious release of radioactive materials could not occur. Any malfunction will destroy the plasma (intensely hot hydrogen gas) and stop the reaction.

2. The amount and hazard of the radioactive materials produced by fusion will be much less than with fission reactors. The greatest hazard of a fusion reactor will be the release of radioactive tritium either as a gas or in the water, but it presents much less of a threat than fission products.

3. Shipments of radioactive fuels will not be necessary.

4. Far smaller quantities of radioactive wastes will need to be stored. Fusion, it appears, will be as environmentally benign as any energy technology except direct use of solar energy.

5. The danger of theft of fuel materials will not be present, because fusion will not produce materials which can be side-tracked for bomb making.

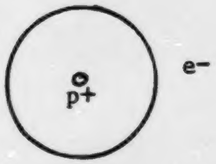
6. Fusion's fuel (hydrogen) source is water, which is cheap and essentially inexhaustible. The supply of water is so large that fusion could be, for all practical purposes, classified as a renewable energy resource. When dealing with fusion's fuel, a little bit goes a long way. Theoretically, the top quarter-inch of water in one of Arkansas' larger lakes could provide sufficient electricity for the entire state for 100 years.

7. Fusion sytems could be used directly or indirectly to produce combustible fuels, such as hydrogen, snythetic natural gas, and alcohol, from water and gases in the air.

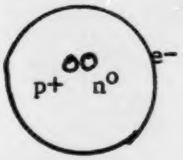
8. Fusion reactors might lead to the development of a fusion torch that could vaporize junk and other solid wastes and convert them back to their basic elements for recycling.

STUDENT BACKGROUND INFORMATION
(Continued)

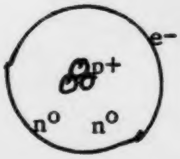
The Three Isotopes of Hydrogen



1. **HYDROGEN:** One proton in nucleus; one electron orbiting nucleus.



2. **DEUTERIUM:** One proton and one neutron in nucleus; one electron orbiting nucleus.



3. **TRITIUM:** One proton and two neutrons in nucleus; one electron orbiting nucleus.

However, there are incredibly difficult and complex problems to overcome before fusion as a harnessed energy source becomes a reality. Man has mastered uncontrolled nuclear fusion in the hydrogen bomb, but after 25 years of research, scientists have yet to master controlled nuclear fusion. There are three extremely difficult requirements for achieving a sustained fusion reaction and they must all be attained simultaneously. The basic difficulty is that the postively-charged nuclei repel one another, and for fusion to occur they must be pressed and held together with tremendous force. This requires: 1) heating the fuel atoms to about 100 million °C to convert the atoms into a plasma and to allow ignition of the fusion reaction; 2) forcing and holding the plasma together long enough (one second) for a sufficient fraction of the fuel atoms to fuse; and, 3) recovering sufficient net useful energy to make fusion a worthwhile source of energy.

Scientists Hope to Perform One of Nature's More Awesome Tricks

Because no known material can contain fuel heated to such ultra-high temperatures, much of the past research in nuclear fusion concentrated on trying to find a "magic bottle" that could force and hold together the hot plasma long enough for self-sustaining fusion to occur. The two major approaches are magnetic confinement and inertial containment.

In the magnetic confinement approach intense magnetic fields are used to hold the plasma of charged nuclei and electrons together. The most promising magnetic approach is the Soviet-designed tokamak, in which the plasma is confined in a doughnut shape by two magnetic fields. A giant tokamak fusion test reactor at Princeton University, funded by the federal government, has achieved a temperature of 700 million °C for a fraction of a second. In 1983, this Princeton reactor is expected to reach the break-even point (producing as much energy as it uses).

The inertial containment approach would use a series of high powered laser beams to bombard and implode a small fuel pellet from all sides to achieve a temerpature high enough to ignite fusion. Laser ignition development, also federally funded, is going on at the University of California Lawrence Livermore laboratory. Major problems are the development of lasers with enough power, and the containment and use of the sudden release of energy, which occurs as a shock wave that could damage or destroy the containment vessel.

Beyond the scientific challenge, there remains the considerable engineering task of developing and building a workable nuclear fusion reactor and commercial power plant. One difficult engineering problem is the sharp temperature difference required over a short distance. At the center of the reactor, the plasma may be 100 million °C, but only six feet away, where the magnets are located, the temperature must be near absolute zero (-273°C). And the entire massive chamber must be maintained at a near perfect vacuum.

The scientific, engineering, and economic problems associated with nuclear fusion are mind-boggling. Harnessing the energy of fusion poses the greatest technological challenge ever faced by mankind. How soon might fusion be available? If everything goes right -- including enough government funding -- laboratory feasibility might be established by 1985, and commerical feasibility sometime after 2000 - 2020. At best, fusion is a long-term (21st century) energy possibility.

STUDENT BACKGROUND INFORMATION

The environmental and socio-economic problems which will accompany fusion seem of less concern than those associated with other energy alternatives (except the direct use of solar radiation). Fusion will, however, continue one trend which itself may pose a socio-economic problem: The increasing size, complexity, and centralization of our energy production industry. There are questions that need to be asked in this area -- but there may be time to ask them.

LESSON #49

CATEGORY: Sources

ENERGY TYPE: All

TITLE: Energy and Clothing

GRADE LEVEL: 10-12

INFUSE WITH SUBJECT AREA:
Home Economics
Social Studies

TIME NEEDED: One Period

MATERIALS:
None

OBJECTIVES:

1. The students will be able to identify various sources of energy in providing clothing.
2. The students will be able to identify processes of clothing manufacturing that are energy consumptive.
3. The students will be able to identify various occupations associated with clothing manufacturing and energy consumption.
4. The students will propose various methods of reducing demands on energy consumption.

TASK ANALYSIS:

The students should use assessment, library research, deduction, decision-making and class discussion to accomplish the four objectives in the lesson.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheet 49.3

2. Steps in Lesson
   Objective #1: The students will be able to identify various sources of energy in providing clothing.

   a. Students will list all the garments they have worn within the past 24 hours. Under each garment listed, list all the materials used in making it and the content of the materials, i.e., wood, polyester, leather, metal, etc. With each item identify the sources of energy used in its development. Have students be specific in their answers.

   Objective #2: The students will be able to identify processes of clothing manufacturing that are energy-consumptive.

   a. Students will list all energy consumptive processes affiliated with clothes manufacturing. Teacher will assist students in forming a reverse chain of energy-related events that took place for their pieces of apparel to become a reality. For example, a T-shirt is made of cotton. Cotton, in turn, is planted, watered, and sprayed with various farm implements. Each implement is energy-consumptive, and each implement has a resource orgin that required energy

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This lesson was written by Alan Peek.

to convert into its current form. Teacher will encourage students to be specific in their lists.

Objective #3: The students will be able to identify various occupations associated with clothing manufacturing and energy consumption.

a. Students will list all occupations associated with any aspect of clothing manufacturing from their lists, and any occupation related to energy sources. Teacher will encourage students to be specific.

Objective #4: The students will propose various methods of reducing demands on energy consumption.

a. Students will use gathered information to develop various methods that people can use to reduce energy demands. Teacher will ask students to develop ideas geared toward a minimum of 25 percent energy reduction.

3. Evaluation

Teacher can use Student Worksheet 49.3 to evaluate students

3. Follow-Up Activities

a. Teacher may request a resource person who has knowledge of agricultural practices, clothing manufacturing or other fields that relate to the energy-consumption list complied by students.

b. Teacher may request a resource person that has knowledge of marketing, personnel or other fields that relate to the occupation list compiled by students.

Student Worksheet

Evaluation

Instructions: Complete the following information concerning this piece of apparel.

Clothing Apparel	Physical Source(s)	Occupation(s) Involved	Energy Source(s)
Leather Shoes			

Student Worksheet

Evaluation
ANSWERS

Clothing Apparel	Physical Source(s)	Occupation(s) Involved	Energy Source(s)
Leather Shoes	1. Animal Skin	1A Ranching	1Aa Grass-Growth-Sun
			1Ab Gasoline usage-Fossil Fuels-Sun
		1B Animal Processing	1Ba Electricity-(cleaning, drying, cutting, sewing of leather) Hydroelectric Nuclear ,
	2. Cotton	2A Farming	2Aa Cotton growth -Sun
			2Ab Gasoline usage-Fossil Fuels-Sun
	3. Plastic	3A Oil Drilling	3Aa Gasoline usage-Fossil Fuels-Sun
			3Ab Electricity-Hydroelectric Nuclear ,
		3B Oil Transportation	3Ba Gasoline usage-Fossil Fuels-Sun
		3C Oil Refining	3Ca Gasoline usage-Fossil Fuels-Sun
			3Cb Gasoline usage-Fossil Fuels-Sun
		3D Oil Manufacturing	3Da Electricity-Hydroelectric Nuclear ,
			3Db Gasoline usage-Fossil Fuels-Sun
	4. Rubber	4A Farming	4Aa Rubber Tree Growth-Sun
			4Ab Gasoline usage-Fossil Fuels-Sun

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LESSON #50

CATEGORY: Conservation

ENERGY TYPE: All

TITLE: Energy in Art

GRADE LEVEL: 10-12

INFUSE WITH SUBJECT AREA:
Art

TIME NEEDED: 7-9 Periods

MATERIALS:

Record player
Record albums
Water colors
Paint brushes
Water color paper (4 sheets/student)
Pictures of solar houses
Pictures of underground dwellings (schools if possible)
Picture of a module home
Drawing paper and pencil
Junk (for sculpture)

OBJECTIVES:

1. The students will use original ideas in order to communicate about energy through art.
2. The students will determine how energy availability has been reflected in architectural styles and use this knowledge to draw a futuristic home.
3. The students will construct an energy-free, three-dimensional sculpture from junk and list energy sources of junk articles.

TASK ANALYSIS:

The students should be able to use art skills of basic drawing, composition, percentage of space, color values, architectural styles and three-dimensional sculpture.

PROCEDURE:

1. Preparation
   Duplicate Student Worksheet 50.5.
   Read Teacher Background Information (50.4).
   Gather above-listed materials.

2. Steps in Lesson
   Objective #1: The students will use original ideas in order to communicate about energy through art.

   Distribute Student Worksheet 50.5

This lesson was written by Alan Peek

a. In Activity #1, students will spend one period relating music and painting and energy. Teacher will ask the students: What is energy? What are some energy sources? What are some ways we use energy in the classroom? Is energy used whenever we create a work of art?

b. Teacher will play four different beats or tempos using suitable recordings. Have students watercolor to the beat using the following art elements: form, color, line, and texture to create a picture. Each picture should reflect a different tempo and style.

c. Teacher will ask the students: Does music release energy? Does sound wavelength have anything to do with energy? If so, how? How did music affect the aesthetic value of each painting? Can you tell from the painting that it reflects a specific beat of music?

Objective #2: The students will determine how energy availability has been reflected in architectural styles and draw a futuristic home.

a. In Activity #2 students will spend three to four periods observing various forms of energy-oriented architecture and drawing a futuristic home. Teacher will ask the student: What ways has architecture changed over the last years? Look at the type of structures that presently exist and look at the construction devices that govern the form, and of the impact technology has had on the design of buildings. Ask: How have building materials changed in the last 25 years?

b. Students will draw a futuristic home. Consider what sources of energy will most likely be used in 2000 A.D., and new building materials. Plan your home for maximum attractiveness and liveability. Consider concepts of mass, space, plane, texture, and proportion.

c. Students will "show and tell" their drawing, its energy efficiency as a home, and its energy source(s). Teacher will ask students: What does it mean to have an energy-efficient building? How can a home be made more efficient? How will solar energy devices affect styles of architecture? (Show pictures of solar heated/cooled homes.) How aesthetically pleasing are they? (Show a pleasant-appearing underground building.) What effect on energy efficiency would one gain by building this way? Does this kind of building affect "visual pollution?" (Explain "visual pollution"). In what ways do you think new products such as plastics, steel, and urethane foam will affect future architecture styles? How will modular homes change the style of architecture? (Show students a picture of a modular home.)

Objective #3: The students will construct an energy-free, three-dimensional sculpture from junk and list energy sources of junk articles.

a. Students will gather various pieces of junk and bring to class. These objects should be recycled into a very aesthetic piece of sculpture. It should be constructed without the aid of power tools.

b. Students will spend three to four periods constructing a sculpture.

c. Students will in the last period of Activity #3, list the sources of energy needed to make the various pieces of the sculpture, place the list beside the sculpture, and name the sculpture. Each student will list the various pieces of junk used in the sculpture and list the sources of energy used in manufacturing each piece of junk in the sculpture. The list of junk with the sources of energy and a title of the piece of art can be placed beside the sculpture in a special exhibit on energy in a school display case.

3. Evaluation

Teacher may evaluate each student on his/her ability to create, to follow the directions given him/her and to use the various skills listed in TASK ANALYSIS.

4. Follow-Up Activities

Teacher may create a class project, such as a mural, sculpture, etc., in which each class member may participate. Teacher may set theme for the projects, such as "Energy: Yesterday, Today and Tommorrow," or "Ways We Use Energy." Have various class members contribute different components to the project. Place the work, along with the other projects completed thus far, on display either in the room or in a school display case.

TEACHER BACKGROUND INFORMATION

Source:

Kathy Erickson. Award Winning Energy Education Activities for Elementary and High School Teachers. United States Department of Energy: Washington D.C. 1979.

"Energy in Art" uses a well-known tool of art construction: originality. High School art teachers are constantly looking for creative ways to teach basic art concepts. The activities in this lesson accomplish basic art concepts with the emphasis being placed on energy usage.

"Energy in Art" helps students explore architectural changes, examine building materials, and recycle discarded objects. The teacher uses easily-obtained materials and needs very little outside preparation in implementing "Energy in Art" into art classes. By this time, students should have had some contact with energy usage and the sources of energy in science classes. Most will have acquired some competence in basic drawing, composition, perception of space, color values, and some understanding of architectural styles. They probably have learned the elements of sculpture in beginning art classes. This lesson provides for the further development and maintenance of these skills.

It will be helpful to the teacher using the lesson to examine carefully the overall organization of the lesson before starting to use it. There are three activities, but each could be taught separately if the teacher wishes.

"Energy in Art" is a seven to nine period lesson dealing with your ability to interpret the relationships between energy and a) watercolor, b) architecture, and c) sculpture.

The lesson consists of three activities. Activity #1 lasts one period and deals with watercolor, music, tempo, energy in sound and energy in style. Try your best to use self-expression according to the art tools, and variety of music provided.

Activity #2 lasts three to four periods and deals with energy use in architectural construction. The student is required to use past skills learned in art, such as line drawing, depth perception, etc., to complete this activity.

Activity #3 lasts three to four periods and deals with energy resources in terms of discarded "junk" articles, sculpture, and energy sources. Examples of such above listed articles and their respective energy sources are: a) polyester - petroleum - plants - sun; b) wood - sun, c) metal - rock.

GLOSSARY

Active solar system: System that needs mechanical means (pumps, fans, etc.) to harness direct solar energy.

Anthracite: "Hard coal;" high in heating value, low in moisture content.

Barrel: Liquid measure of petroleum, usually crude oil, equal to 42 U.S. gallons.

Biomass: Living material and its waste products; usually limited to plant material: trees and other living plants, agricultural crop residues, forestry residues, animal manures.

Bituminous coal: "Soft coal;" younger and lower in heating value than anthracite; older and higher in heating value than lignite.

Breeder reactor: Nuclear fission reactor that produces more fuel than it consumes by converting nonfissionable uranium-238 into fissionable plutonium-239.

British Thermal Unite (BTU): An engineering unit of heat energy; the quantity of heat necessary to raise the temperature of one pound of water one degree F. (about one-quarter of a calorie).

Coal: Solid, combustible organic material containing 55 to 90% carbon mixed with small amounts of hydrogen, oxygen, nitrogen, and sulfur.

Cogeneration: Combined production, usually in industry, of electricity and heat.

Conversion, energy: Process of changing energy from one form to another (example: burning gasoline in an automobile: chemical energy to mechanical energy.

Demand, energy: Amount of energy required to satisfy energy needs.

Efficiency (conversion efficiency): Ratio of useful work or energy output to total work or energy input.

Electricity: Energy composed of moving electrons; for man, an intermediate form of energy which can be conveniently converted to mechanical energy or directly into heat or light.

Electron: Negatively-charged particle, having little mass, and revolving around the nucleus of an atom.

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Energy: Ability or capacity to do work by pushing or pulling some form of matter.

Energy crisis: Shortfall or catastrophic price rise for one or more forms of useful energy, or a situation in which energy use is so great that the resultant environmental degradation threatens human health and welfare.

Enhanced oil recovery: Use of heat, chemicals, or other methods to augment oil recovery.

Environment: Aggregate of external conditions that influence the life of an individual organism or population.

Fly ash: Small, solid particles of ash and soot generated when coal, oil, or waste materials are burned.

Fossil fuel: Remains of dead plants and animals of a previous geologic era that can be burned to release energy (examples: coal; crude oil; natural gas).

Fuel: Any material that can be burned or undergo nuclear fission or fusion to produce heat.

Generating capacity, electrical: Maximum production of an electric power plant; usually measured in megawatts (MW).

Geothermal energy: Heat energy produced when subsurface rocks are heated to high temperature by energy from the decay of radioactive elements in the earth.

Half-life: Length of time required for one-half the atoms in a given amount of a radioactive material to decay into another isotope.

Heating value: Amount of heat produced by the complete combustion of a unit quantity of fuel.

Hydropower: Conversion of mechanical energy in falling water to electrical energy by means of a turbine generator.

Isotope: Form of a chemical element that has the same number of protons in the nucleus of each atom but a different number of neutrons.

Kilowatt-hour (KWH): Measure of electrical output; 1 KWH = 1KW of power for 1 hour of generation.

Lead time: Time period required from initial planning to operational stage of a new energy facility (example: presently about 12 years for a nuclear fission power plant in the U.S.); also refers to time period necessary to develop a new energy technology and phase it into society (example: currently about 50 years for nuclear fusion in the U.S.).

Lignite: Low-grade, brownish-black coal; low in heating value, high in moisture content.

Load, electrical: Amount of power needed to be delivered at a given instant in time on an electric system.

MCF (Thousand Cubic Feet): Standard measurement of natural gas at a specified temperature and pressure.

Megawatt (MW): Unit of electric power; equals 1000 kilowatts or 1 million watts; MW capacity rating of electric power plants are usually the MW generated per day.

Natural gas: Natural deposits of gases consisting of 50 to 90% methane and small amounts of other hydrocarbons such as propane and butane.

Net useful energy: Total useful energy of a resource as it is found in nature minus the useful energy needed to find, extract, and process the resource, upgrade energy quality, meet environmental and safety requirements, and deliver the energy to the user minus the useful energy lost as a result of the Second Law of Thermodynamics and the uses of unnecessarily inefficient and wasteful energy systems.

Neutron: Uncharged particle contained within the nucleus of an atom.

Nonrenewable resource: Resource that can be used up or at least depleted to such a degree that further recovery is too expensive.

Nuclear energy: Energy liberated by a nuclear reaction (fission or fusion) or by radioactive decay.

Nuclear fission: Process in which the nucleus of a heavy element splits into 2 or more nuclei of lighter elements, with the release of neutrons and substantial amounts of energy; most important fissionable materials are uranium-235 and plutonium-239.

Nuclear fusion: Process in which the nuclei of 2 light, nonradioactive elements (such as hydrogen isotopes) are forced together at ultrahigh temperature to form the nucleus of a slightly heavier element (such as helium) with the release of substantial amounts of energy.

Nuclear reactor: Device in which a nuclear chain reaction can be initiated, maintained, and controlled.

Oil shale: Rock containing solid organic matter (kerogen) that yields crude oil when heated to high temperature.

Passive solar system: System that harnesses direct solar energy without mechanical devices; usually uses the structural design of a building to collect and convert solar energy.

Petroleum (or crude oil): Liquid, combustible organic material containing a mixture of hydrocarbon compounds plus small amounts of oxygen, sulfur, and nitrogen compounds and found in natural subsurface reservoirs; when refined produces many distillates, such as propane, fuel oil, kerosene, gasoline.

Photosynthesis: Complex process that occurs in the cells of green plants whereby sunlight is used to combine carbon dioxide and water to produce oxygen and simple sugar such as glucose.

Power: Rate at which work is done or energy is expended; measured in units of energy per unit of time such as calories per second, and in units such as watts and horsepower.

Propane: Hydrocarbon which exists under normal pressures and temperatures as a liquid; however, it gasifies easily and for many purposes it is a substitute for natural gas; main source of propane is from refining of crude oil.

Proton: Positively charged particle contained within the nucleus of an atom.

Quality, energy: Ability of a form of energy to do useful work; high-quality energy (such as high-temperature heat, fossil fuels, and nuclear fuel) is concentrated, whereas low-quality energy (such as low-temperature heat and sunlight) is dispersed or diluted.

Renewable resource: Resource that potentially cannot be used up; either it comes from an essentially inexhaustible source (such as solar radiation), or it can be regenerated by natural or human-devised cyclical processes if it is not used faster than it is renewed.

Reserve, energy: That part of a total energy resource that has been identified and is generally capable of being developed under existing economic and technological conditions.

Resource, energy: Any material potentially usuable by man as an energy source; includes estimates based on evidence for portions still undiscovered and those whose development will require more favorable economic conditions or better technology than presently exists.

Solar cell: Device, usually made of silicon, that converts sunlight directly into electricity; also known as photovoltaic cell.

Solar collector: Device which collects and converts solar energy into a more useful form.

Solar energy: Energy produced by the fusion reaction occurring in the sun, which reaches the earth as radiant energy.

Surface mining: Process of removing overburden (overlying materials) so that underlying useful mineral deposits can be extracted.

Tar sand: Deposit containing fine clay and sand mixed with water and variable amounts of black, high-sulfur, molasses-like tar, termed bitumen, which is about 83% carbon.

Thermodynamics, First Law of (also know as the Law of Conservation of Energy): In any ordinary physical or chemical change, energy is neither created nor destroyed but merely changed from one form to another.

Thermodynamics, Second Law of (also known as the Law of Energy Degradation): In all conversions of heat energy to work, some of the energy is always degraded to a more dispersed and less useful form, usually heat energy given off at a low temperature to the surroundings, or environment.

Turbine: Rotary engine actuated by the reaction of a current of fluid (such as water) or gas (such as steam or air); usually made with a series of curved vanes on a central rotating spindle.

Waste, radioactive: Materials and equipment from nuclear operations which are radioactive and for which there is no further use.

Wind energy: Mechanical energy of moving air.

SELECTED REFERENCES

Informational Materials for Teachers

ARKANSAS ENERGY OFFICE, 3000 Kavanaugh, Little Rock, AR 72205 Call toll-free 1-800-482-1122 (or 371-1370 in Little Rock) for list of available titles.

ARKANSAS AND ENERGY: A LOOK AT THE ALTERNATIVES, by Paul L. Butt, 1979, 139 pp. Arkansas Ecology Center, P.O. Box 5754, Little Rock, AR 72205. $3.00 plus 75¢ postage and handling (only prepaid orders accepted). A brief examination of the alternatives in Arkansas' energy future. In adjusting to scarcities and higher prices for energy, Arkansas will need to make some difficult decisions about increasing energy production and reducing energy consumption. Knowledge is essential to informed decision-making.

ENERGY, A GROWING NATIONAL PROBLEM, Illustrated 16 page report on our national energy problem and what can be done about it. Glossary of energy terms. Single copy free; additional 20¢ each; 50 or more, 16¢ each. National Wildlife Federation, 1416 Sixteenth St., NW, Suite 507, Washington D.C. 20036.

ENERGY PUZZLE: HOW YOU FIT IN, Alliance to Save Energy, 1925 K Street, NW, Suite 507, Washington, D.C. 20006. Answers some of the questions about how we got where we are today and how we can solve some of our energy problems.

INK: World of Research Inc., 11720 Sorento Valley Road, San Diego, CA 72121; free for one, 2-9 copies $1.00. Magazine current alternatives described; book reviews of energy books.

LEAGUE OF WOMEN VOTERS OF THE UNITED STATES, Sales Department, 1730 M Street, NW 10th Floor, Washington D.C. 20036. Send the number of publication and a check for cost of publication plus 50¢ handling charge. "Energy Factsheet Kit" #552, $1.50, more than 20 sheets on all topics from offshore drilling to utility rate reform, 1974-79, 2 pp., each. "A Nuclear Waste Primer" #391, $1.25, 1980, 36 pp. "Energy Dilemmas: An Overview of U.S. Energy Problems and Issues", #688 $1.00 each, 5-9 copies are 80¢ each, 10-49 copies 70¢, 1977, 39 pp. "Energy Options: Examining Sources and Defining Governments' Role", #628, $1.00 each or same rate as "Dilemmmas", 1977, 55 pp. Ask for a catalog listing all League publications.

TIPS FOR ENERGY SAVERS: Order from Energy Conservation Now, Pueblo, Colorado 81009. Offers practical and simple ways to save energy in the kitchen, workshop, garden, and car; includes energy saving consideration when buying appliances and other household merchandise. 1978, 46 pp.

Selected Department of Energy Publications: Order from U.S. Department of Energy-Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee 37830. Available free upon request.

HOW TO UNDERSTAND YOUR UTILITY BILL: A guide to reading electric and gas meters and checking utility bills, so that householders may know how much energy they use and how effectively they conserve it. 1977. 12 pp.

I'VE GOT A QUESTION ABOUT USING SOLAR ENERGY: This phamplet answers twelve of the solar questions most often asked by people writing to the Department of Energy. 1978. 32 pp.

NUCLEAR ENERGY: Tells how nuclear energy generates electricity 1976. 10 pp.

OIL: Explains how oil is produced, transported, and used. 1977. 16 pp.

PROFESSIONAL ENERGY CAREERS: A brief outline of the professional careers in the energy fields. 1979. 45 pp.

PUT THE SUN TO WORK TODAY: Solar Principles, equipment, and costs for homeowners considering the installation of solar heating and cooling systems, in addition to a brief account of renewable energy obtainable from the winds, waterpower, photovoltaic cells, thermal conversion, biomass, ocean thermal, and satellite systems. 1978. 24 pp.

SOLAR ENERGY FOR AGRICULTURE AND INDUSTRY: How the sun can be used for a variety of application, such as providing power to dry crops, heat farm buildings, and provide process heat for industry. 1978. 9 pp.

FACT SHEETS: (Some sheets are quite technical)

1. Fuels from Plants (Bioconversion)
2. Fuels from Wastes (Bioconversion)
3. Wind Power
4. Electricity from the Sun I (Solar Photovoltaic Energy)
5. Electricity from the Sun II (Solar Thermal Energy Conversion)
6. Solar Sea Power (Ocean Thermal Energy Conversion)
7. Solar Heating and Cooling
8. Geothermal Energy
9. Energy Conservation: Homes and Buildings
10. Energy Conservation: Industry
11. Energy Conservation: Transportation
12. Conventional Reactors
13. Breeder Reactors
14. Nuclear Fusion
15. New Fuels from Coal
16. Energy Storage Technology
17. Alternative Energy Sources: Enviromental Impacts
18. Alternative Energy Sources: A Glossary of Terms
19. Alternative Energy Sources: A Bibliography

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Curricular Materials

Ordering information for the following curriculum materials: U.S. Department of Energy-Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee 37830: free single copies; lesson plans for teachers with student worksheets included. Bulk quantities/complete sets of individual titles sent only to teachers, librarians, or energy information centers. Please use your official letterhead stationery in ordering.

This material was produced by the National Science Teachers Association under contract with the U.S. Energy Research and Development Administraction (Now U.S. Department of Energy). The facts, statistics, projections, and conclusions are those of the authors. The following is an annotated list of the titles available.

ENERGY, ENGINES, AND THE INDUSTRIAL REVOLUTION (grades 8-9). This unit examines some of the broad social and economic upheavals that took place during the 18th century. It calls special attention to the role of energy in this dramatic period of history which ushered in our own technological age. The development of the steam engine is highlighted. 1972. 82 pp.

ENERGY CONSERVATION: UNDERSTANDING AND ACTIVITIES FOR YOUNG PEOPLE (grades 7-9). Discusses the meaning of energy, its sources and limitations, and suggests conservation activities. 1975. 20 pp.

ENERGY HISTORY OF THE UNITED STATES (grades 8-9). Charts the growth of American energy use and traces the history of the major sources of energy (coal, wood, and oil) in the United States. 1978. 117 pp.

ENERGY TRANSITIONS IN U.S. HISTORY (grades 8-9). This is essentially a history unit. It is aimed at giving students an understanding of the influence that each source of energy has on the culture and of the impact of energy change. 1979. 120 pp.

MATHEMATICS IN ENERGY (grades 8-9). This packet is designed to infuse energy concepts into junior high math classes. The unit deals with a wide range of energy math including conversions, statistics, and the manipulation of energy units, (BTU's WATTS, Calories, etc.) 1978. 64 pp.

TWO ENERGY GULFS (Grades 6-7). This is a unit guided by two main principles; 1) that energy-use shapes and changes the way people live, and 2) that people depend on energy. Students expand their view of culture by making comparisons between the way they use energy and the way others use it. From case studies and by gathering information to complete a social profile, students begin to generalize a broader picture of two societies, and discuss their interdependence. 1979. 95 pp.

TRANSPORTATION AND THE CITY (grades 8-9). There are four study units including "Getting There", buying a dream car and planning if you can buy the gas, and "Shut Down by Tin Lizzie", a student reading exercise showing how small American towns declined as a result of the automobile. 1979. 46 pp.

AGRICULTURE, ENERGY, AND SOCIETY (grades 10-12). This interdisciplinary unit helps students examine the nature of present-day agricultural methods and study the impact of these methods on existing energy resources. 1977. 335 pp.

ENERGY CONSERVATION IN THE HOME: AN ENERGY EDUCATION/CONSERVATION CURRICULUM GUIDE FOR HOME ECONOMICS TEACHERS. This resource book will help home economics students conserve energy in their homes and lives. 1977. 335 pp.

ENERGY IN THE GLOBAL MARKETPLACE (grades 9-11). This unit is designed to introduce students to the global marketplace in energy and to the causes and implications of the interdependence created by that marketplace.

HOW A BILL BECOMES A LAW TO CONSERVE ENERGY (grades 9-12) Study units include "Case Study of a Bill", which describes how the 55-mph national speed limit became a law and takes the student through the lawmaking process; and "A Congressional Hearing" in which students play typical roles at a hearing on a national speed limit bill in a simulation game. 1978. 115 pp.

U. S. ENERGY POLICY---WHICH DIRECTION? (grades 9-11). This packet prompts students to consider some questions about future uses of coal, our nation's largest fossil fuel energy reserve. 1979. 73 pp.

WESTERN COAL: BOOM OR BUST? (grades 9-11). This packet prompts students to consider some questions about future uses of coal, our nation's largest fossil fuel energy reserve. 1979. 73 pp.

PROFESSIONAL ENERGY CAREERS. New skills will be required to design and operate the new energy machinery and minimize its effect on the environment Careers described, education requirements outlined, sources of information given for each career. 1979. 45 pp.

ENERGY AND EDUCATION: A NEWSLETTER. National Science Teachers Association, 1742 Connecticut Avenue, NW, Washington, D.C. 20009; free; published five times each school year in conjunction with the U.S. Department of Energy.

SEED (School House Energy Efficiency Demonstration). Includes a classroom guide section with student sheets to duplicate so that students may conduct an energy survey of their school; activity lessons for grades 4-12 are included. Order a free copy from: Tenneco, Inc., Public Affairs Department, P.O. Box 2511 Houston, Texas 77001. (One copy was sent to each superintendent in Arkansas by Tenneco in May 1980.)

Films

Arkansas Energy Office has the following films for free loan; call 371-1370 or toll free 1-800-428-1122 and tell when you want the film. The date you will receive the film will be confirmed by mail; return postage is to be paid by the school borrowing. Ask about other films that may be available but not listed below.

ENERGY: THE FACTS . . . THE FEARS . . . THE FUTURE: Anchored by Walter Cronkite/CBS News Production; Overview which discusses the causes and ramifications of the possible solution to the energy crisis. Junior High School to Adult.

SOLAR ENERGY: THE GREAT ADVENTURE: A new look at our nation at its innovative best. Introduces an unusually diverse group of people who have developed their own solar energy systems, both urban and rural. 28 1/2 minutes.

VANPOOLING; two prints.

HOTTEST SHOW ON EARTH: solar

WATT NEXT: compendium of USDOE advertising

SOLAR PROMISE: Depicts passive and active solar on the market; concepts clearly presented; out-of-door applications. Grade 7 to Adult. 28 minutes.

FEATHERFOOT: 10 prints. (Received 6/80) Plus 1 video cassette on loan as follows: 4 to Revenues Division of DFA, Office of Driver Services, 1 to Department of Education, Driver Education Division, 1 to Parks and Tourism, 2 are kept in Energy office for presentations and short-term loan-out.

ENERGY: A NEW LOOK: Oil, it's supply and demand.

DECISION: ENERGY FOR THE FUTURE; Gas lines or no gas lines, many Americans refuse to believe that we face a shortage of fossil fuels. The amusing animated film uses graphs and manipulates screen time to demonstrate to children and adults that our dependence on fossil fuels is an extremely recent phenomenon, which if continued will lead to disasterous shortfalls. But there is a clear alternative--to switch to renewable energy sources. We should act now so that we can be proud to say "It all began with us". Junior High to Adult. 12 min.

LOOK TO THE SUN - Solar: Junior High to Adult, 12 Minutes.

AVAILABLE FROM THE ARKANSAS DEPARTMENT OF EDUCATION FILM LIBRARY

ENERGY: THE DILEMMA #5004 22 minutes

Surveys our continuing increase in the use of energy drawn from our three fossil sources and from nuclear energy, and the causes of the continuing increase in demand. Examines each fuel source: oil, gas, coal and nuclear, with respect to the potential supplies, mounting costs, environmental hazards and the special problems of nuclear reactors. The economic impact of imported oil and rising fuel costs are dealt with. Examines government and industry forces that are shaping energy policy. Concludes with a brief summary of potential new energy sources and the dilemma we face if our demand continues to grow, outstripping our supply.

ENERGY: THE NUCLEAR ALTERNATIVE #5007 22 minutes

The film deals with the nuclear power program as a controversy, with authorities, scientists, engineers, industry spokesmen and concerned citizens expressing their views.

An introduction describes the original government plans and the current scaled back nuclear development program, and explains with animation how a reactor powers a turbogenerator to make electricity.

Thereafter the film focuses on two main areas of concern, plant safety and waste management. The problems of human error and mechanical failure are discussed in light of the Three Mile Island accident. Failure of a back-up cooling system is described wtih animation. The need and attempts to settle upon a permanent waste storage program are described. All sides criticize the government's inept nuclear record, both early and current.

ENERGY: NEW SOURCES #5006 24 minutes

The film surveys those new sources of energy which have the greatest potential. Included are: solar, geothermal, nuclear fusion and synthetic fuels from coal or oil shale. The survey of solar energy includes an analysis of water and space heating, biomass sources (methane and alcohol), the oceans, wind power, ways of concentrating heat for electrical uses, and photovoltaic conversion. The new sources are examined in the light of : how much energy can they provide? How soon? At what cost? With what environmental impact?

The film points out that it will take time for any of these new sources to replace a significant percentage of our fossil fuel use. Therefore we will have to cut back on our consumption of energy.

ENERGY: LESS IS MORE #6624 21 minutes

Considering the growing shortage of fossil fuels and the time required to develop renewable sources, we are faced with the need to accomplish social goals with less energy. The film explores the prospects for conserving energy in three areas: transportation, industry and buildings.

The sorry case of the automobile is reviewed, and the prospects of fuel savings through design and more efficient use considered. The difficulty of revitalizing public transportation in light of our automobile addiction is probed. By contrast, industry has reacted quickly to high fuel prices with resultant savings, a clear case of doing the same job with less energy. Cogeneration, a source of great potential savings, is discussed. Prospects and progress in making our office buildings and homes more energy efficient are dealt with. Doing more work with less energy is the cleanest short term solution to the energy dilemma

EVALUATION OF STUDYING ARKANSAS' VALUABLE ENERGY

Circle Unit Level K-3 4-6 7-12

Type of Class (math, science, social studies, etc.)____________________

Grade Level__________Teacher's Name (Optional)____________________

School____________________City____________________

1. **CONTENT:** Did the students gain appreciably in energy knowledge and understanding?____yes____no. Describe____________________

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2. **WORKSHEETS:** Were the student worksheets appropriate to the interests and abilities of your students?____yes____no. Describe____________________

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3. **ATTITUDE:** Did the students' attitudes improve toward the importance of energy conservation?____yes____no. Describe____________________

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4. **TEACHER BACKGROUND INFORMATION:** Was it adequate?_____Inadequate?____

   Describe____________________

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5. Energy topics which you would like to see included in future revisions.

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6. Other comments (use back of page if needed)____________________

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Return to: Helen Holmes, Coordinator of Economic, Energy, Environmental and Conservation Education; Arkansas Department of Education; Arch Ford Building, Room 404-B; Little Rock, AR 72201